PRELIMINARY REPORT

Evaluation of rare-element pegmatites in NWT

MATERIAL AND SOURCES

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Indian and Northern Affairs Canada **Affaires indiennes et du Nord Canada**

EGS 1988-3 Evaluation Of Rare-Element Pegmatites in NWT; Preliminary, Progress and Final Reports. parts of NTS 27 C; 56 M; 75 M; 76 C; 85 I; & 85 J/1, 8, 9, 16
Canada NWT Mineral Development Agreement
by P. Cherny
3 texts

Price: $6.50

CANADA N.W.T.
MINERAL DEVELOPMENT AGREEMENT

MATERIAL AND SOURCES

INTRODUCTION

The objective of the contract on "Evaluation of Rare-Element Pegmatites in NWT" is the examination of the rare-element populations in the southern Slave Province, Eskimo Hill (Baffin Island) and Chantrey Inlet.

To this end, acquisition of research material in the form of available literature, samples for laboratory research and any other information pertinent to the above pegmatite populations are being collected and prepared for study.

SOUTHERN SLAVE PROVINCE

The main and best known pegmatite-bearing region in the southern Slave Province is that of the yellowknife field. It has been discovered in the nineteen forties, and since that time subject to several rather disjointed and definitely non-systematic studies. Exploration of the field was intermittent, as were the mining activities. Al this past record is reviewed in the most recent study of the field, performed by Meintzer (1987) and Wise (1987) in their Ph.D. theses projects.

The above theses will constitute the main source of data for evaluation of the Yellowknife pegmatite field in the final report.

East of the Yellowknife field, pegmatite-bearing areas are located at Aylmer and McKay Lakes, and at Benjamin Lake to the north of the eastern area of Great Slave Lake. These areas were only superficially inspected in the nineteen forties and fifties, and the only basis for their evaluation consists of the first mapping reports published by Folinsbee (1947, 1949, 1952), Henderson (1943), Lord and Barnes (1954), Stockwell et al. (1968), and Heywood and Davidson (1969).

ESKIMO HILL (BAFFIN ISLAND)

A columbite-bearing pegmatite was first reported from the central Baffin Island, near the southeastern termination of the Barnes Icecap at the proglacial Generator Lake, by Kranck (1955). Mapping reports and Open File reports by COMINCO contain some information on pegmatites of the central Baffin Island in general.

The Eskimo Hill (or PLEX) pegmatite locality was visited by P.C. in 1981 in his capacity of a consultant to the Tantalum Mining Corporation of Canada, Ltd., during the joint-venture project aimed by TANCO and COMINCO at this locality. The COMINCO claims have lapsed in December 1987 and the ground is now open.

The documentation and material collected in 1981 will be used to characterize and classify this locality, and available literature (mainly mapping and metamorphic-structural studies by Jackson and Morgan 1978, Henderson 1980, Henderson and Tippett 1980, Tippet and Morgan 1987) will be searched for clues pertinent to the nature and mineralization of pegmatite population of central Baffin Island.

CHANTREY INLET

To the best of our knowledge, the only report on granitic pegmatites from the vicinity of Chantrey inlet is a verbal one by a prospector who has found beryl of apparently gemstock quality, or at least collectible value for mineral collectors. We will start a search for geological documentation of the Chantrey Inlet region, in order to derive at least tentative evaluation of the significance of the above beryl find.

PROGRESS REPORT

Evaluation of the rare-metal pegmatites in NWT

THE PLEX (ESKIMO HILL) PEGMATITES,

GENERATOR LAKE, BAFFIN ISLAND, N.W.T.

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MINERAL DEVELOPMENT AGREEMENT

LOCATION AND HISTORY

The PLEX pegmatites are located in central parts of Baffin Island, 2.5 km south of the southern shore of the proglacial Generator Lake, at the southeastern termination of the Barnes icesheet ($69^{o}32'N/71^{o}56'W$). The lake has open water surface, on the average, only 10 days/year in the end of July and early August. Consequently, the only practical access is by helicopter from the DEW-line base at Hall Beach or DEW-line stations along the west coast of Baffin Island.

The pegmatites were first described by Kranck (1955) who recognized the main rock-forming and accessory minerals. Later notes came from Henderson (1980) and Henderson and Tippett (1980).

The pegmatites were staked under claim by COMINCO in summer 1979, and examined by Tantalum Mining Corporation of Canada Ltd. personnel (under a joint-venture agreement) plus the present author in 1981. The COMINCO claims expired in December 1987 and the ground is at present open.

REGIONAL GEOLOGY

The broader regional geology and its metamorphic aspects are covered by Jackson and Morgan (1978), whereas larger-scale tectonic evolution is treated by Tippett and Morgan (1987).

The PLEX pegmatites are emplaced along the contact of metasediments overlain at a shallow angle by metabasalts. The metasediments are represented by biotite-quartz-garnet paragneiss, locally studded by subhedral to euhedral staurolite. In the vicinity of the pegmatites, this paragneiss contains abundant porphyroblasts of black tourmaline. The metabasalt is metamorphosed into amphibolite with very low content of

felsic minerals. Exocontact effects are limited to a narrow biotitized seam; tourmaline or other reaction products were not observed. The metamorphism of the country rocks in the area of Generator Lake corresponds to amphibolite facies.

THE PEGMATITES: SHAPE, SIZE, ATTITUDE

Two pegmatites can be distinguished in the field, designated here as the Upper (PX) and Lower (LPX) pegmatite.

The Upper pegmatite is a sill-like body emplaced along the lithological paragneiss/amphibolite boundary. It is exposed on a northwest-facing slope along a length of 80 m, with scattered outcrops discernible along a total length of about 400 m. The pegmatite dips shallowly to the southwest (20-25^{o}, exceptionally up to apparent 50^{o}). Thickness is variable from about 1.2 m in the northeasternmost exposure to a minimum of 2.5 m in the central parts.

The Lower pegmatite is poorly exposed below the central parts of the Upper pegmatite outcrop. Its upper contact can be locally discerned but the footwall contact is hidden, as are the flanks of the cca 15 m long outcrop, under a thick layer of slope talus.

THE PEGMATITES: INTERNAL STRUCTURE

The Upper pegmatite consists of essentially three units: a wall zone, an intermediate (core-margin) zone, and a core.

The wall zone consists essentially of albite, quartz and muscovite, with subordinate garnet and tourmaline. In the northeasternmost exposure of the upper pegmatite, the wall zone is the exclusive constituent of the pegmatite over its entire width, poor in muscovite but extremely enriched in garnet and tourmaline. Both these minerals are intergrown

here with quartz in a quasi-graphic pattern. In the central parts of the pegmatite exposure, the wall zone is relatively thin, enriched in plumose and platy muscovite, poor in garnet and locally lacking tourmaline.

The intermediate (core-margin) zone consists of grey to milky quartz, white blocky K-feldspar, subordinate to accessory book muscovite and columnar tourmaline. Pods of löllingite also occur in this unit.

The core is largely monomineralic, composed of milky quartz but it also contains gigantic columns of black tourmaline (up to 0.15 x 1.5 m), studded by zircon and columbite crystals on their surfaces. In the vicinity of columbite and zircon, the quartz is (brownish) black, with a gradual transition into the milky type.

The lower pegmatite is not exposed enough to reveal its internal structure. The limited outcrop shows virtually exclusively a unit of medium-flaked greenish-yellow muscovite with local small patches of quartz and dispersed pods of albite. Accessory columbite is found disseminated throughout the muscovite masses.

THE PEGMATITES: MINERALOGY AND GEOCHEMISTRY

Albite is present dominantly as cleavelandite. Saccharoidal albite is extremely rare. In the wall zone, albite near contacts with wallrocks shows optical properties corresponding to An_5 - An_7; in the internal parts of the wall zone and in the core-margin, the composition is close to An_2 - An_3.

Microcline-perthite is largely white, with near-maximum values of triclinicity (0.88-0.95). The sodium contents are relatively high (2.48-3.28 wt.% Na_2O), whereas the levels of rare-alkali fractionation are moderate (K/Rb 54-24, K/Cs 1100-3200) (see the results of chemical

analyses in the appendix).

Muscovite belongs without exception to the common $2M_1$, polytype. In the Upper pegmatite, muscovite chemistry is relatively primitive, as indicated by the poor rare-alkali fractionation (K/Rb 25-35, K/Cs 1300-2700), low Li content (0.25-0.27 wt.% Li_2O) and high Fe (total Fe as Fe_2O_3 2.2-2.8 wt.%). In contrast, the medium-flaked muscovite from the Lower pegmatite is much more evolved (K/Rb 10-18, K/Cs 170-680, Li_2O 0.24-0.27; Fe is high but the Fe/Mn ratio is distinctly lower; see the results of chemical analyses in the appendix).

Garnet forms dark red crystals up to 3 cm in size, or quasi-graphic intergrowths with quartz that reach 12 cm across, in the upper pegmatite. The composition is largely close to Alm_{50} $Spess_{50}$, with only very minor Ca contents and Mg below the detection limit of the electron microprobe under standard operating conditions (cca 0.10 wt.% MgO). Only the garnet that occurs in minor quantities with muscovite in the core-margin of the pegmatite reaches the composition of Alm_{22} $Spess_{78}$ (see garnet microprobe analyses in the appendix).

In contrast to the above, garnet from the Lower pegmatite is distinctly more fractionated. Its reddish orange grains, found with albite in the albite clusters within the medium-flaked muscovite masses, range from 59 to 78% in the spessartine content.

Tourmaline is black in color, and ranges from dendritic aggregates finely intergrown with albite, through coarse-grained quasi-graphic intergrowths with quartz, to the aforementioned gigantic columnar crystals in the core. Its composition is somewhat variable within individual crystals, showing oscillatory concentric zoning, but within

relatively narrow limits. Compared to coexisting garnet, the tourmaline is always seen to incorporate Fe perferentially, being very poor in Mn relative to garnet. The Mg content is variable, being the highest along the wallrock contacts (3.40 wt.% MgO) but low in the internal units (0.0-0.6 wt.% MgO). The black tourmaline from the footwall parageneiss is, however, Mg- and Ti-rich. Dravite is the far dominant component in this tourmaline (see microprobe analyses of tourmaline in the appendix).

Beryl was found in only one specimen in the slope talus beneath the Upper pegmatite but above the Lower dike. It is associated with cleavelandite and garnet. The 2.5 x 10 cm crystal is considerably altered and stained by manganese oxides. Consequently no attempt was made to separate pure material for chemical analysis. However, identification was secured by X-ray powder diffraction.

Columbite of the Upper pegmatite forms flat columnar crystals averaging about 1x3x7 cm in size but occasionally reaching 5x10x16 cm. Embedded in otherwise milky quartz, the columbite crystals develop a halo of smoky color up to 15 cm wide. Compositionally, the mineral corresponds to ferrocolumbite with narrow ranges of Fe-Mn and Nb-Ta substitutions (Fig. 2).

Columbite of the Lower pegmatite forms anhedral to brick-shaped subhedral grains that average 1 cm in size. They are somewhat enriched in Ta and distinctly enriched in Mn. Their restricted compositional range is confined to the manganocolumbite quadrangle of the columbite quadrilateral (Fig. 2) (see appendix for compositional data of both columbite types).

Structurally, columbite from both the Upper and Lower pegmatites

display intermediate degrees of cation ordering, with a peculiar bimodal distribution of structural states (Fig. 2). No explanation is available at present for this feature, which is to the best of my knowledge unique. On heating, all examined specimens develop more or less completely ordered structure.

Zircon is found in the form of radial aggregates of columnar crystals averaging 0.6 cm in length, growing on the surface of tourmaline crystals in the core-margin unit and in the core. It is metamict but the structure can be reasonably restored by heating. Metamictization is expressed in the electron microprobe analysis by low total and deviations from stoichiometry. The low content of HfO_2 indicates rather poor fractionation level.

Löllingite was found in the southern end of the main exprosure of the Upper pegmatite. It forms a sizeable pod there, at least 20 cm across, in quartz and K-feldspar of the core-margin unit. It was unambiguously identified by X-ray powder diffraction.

Uranophane was found as an alteration product of zircon. It forms pale-yellow powdery coatings on the surfaces and within fractures of zircon. No compositional data are available but the X-ray powder diffraction data yielded a reliable identification.

Scorodite is an abundant alteration product of löllingite. The green microcrystalline material is contaminated by relics of löllingite and too soft for mounting; consequently, no chemical analysis was possible. However, X-ray diffraction provided an unambiguous identification.

THE PEGMATITES: CLASSIFICATION

The internal structure, rock-forming minerals and the assemblage of accessory phases rank the Upper pegmatite with the beryl-columbite subtype of the beryl type of rare-element granitic pegmatites (Černý 1986, 1988). If the mineralogy at the present level of exposure is characteristic of the whole 3-dimensional body of the pegmatite, we have a considerably anomalous relationship here, with relatively abundant columbite dominant over truly rare beryl. A reverse ratio is the "rule" in pegmatites of this type.

The geochemical signature of the Upper pegmatite corresponds to the range typical of the beryl-columbite subtype, comparable to other occurrences documented by, e.g., Černý et al. (1981) and Meintzer (1987).

The Lower pegmatite cannot be completely characterized because of poor exposure. It could be somewhat more evolved than the Upper body, but pods of more fractionated mica are documented from the central parts of beryl-columbite pegmatites (e.g., Černý et al. 1981, 1988). It is quite possible that the exposed micaceous pod may reside in central parts of a zoned pegmatite which otherwise corresponds, geochemically and paragenetically, to the composition of the Upper pegmatite.

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students, and to Mr. Ron Chapman of the electron microprobe laboratory at the Department of Geological Sciences, University of Manitoba for their extensive help during the laboratory work.

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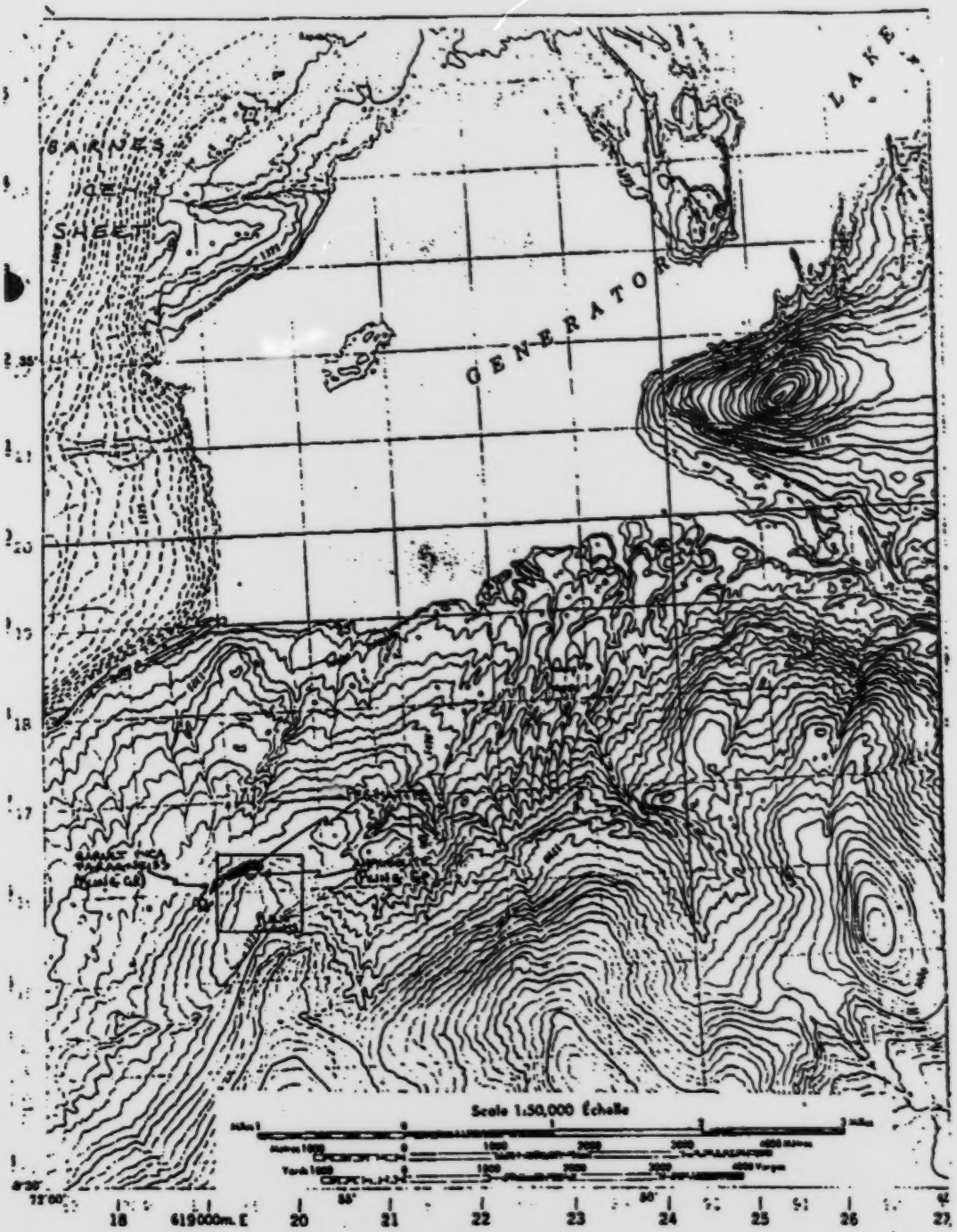

Figure 1. Location of the PLEX pegmatites.

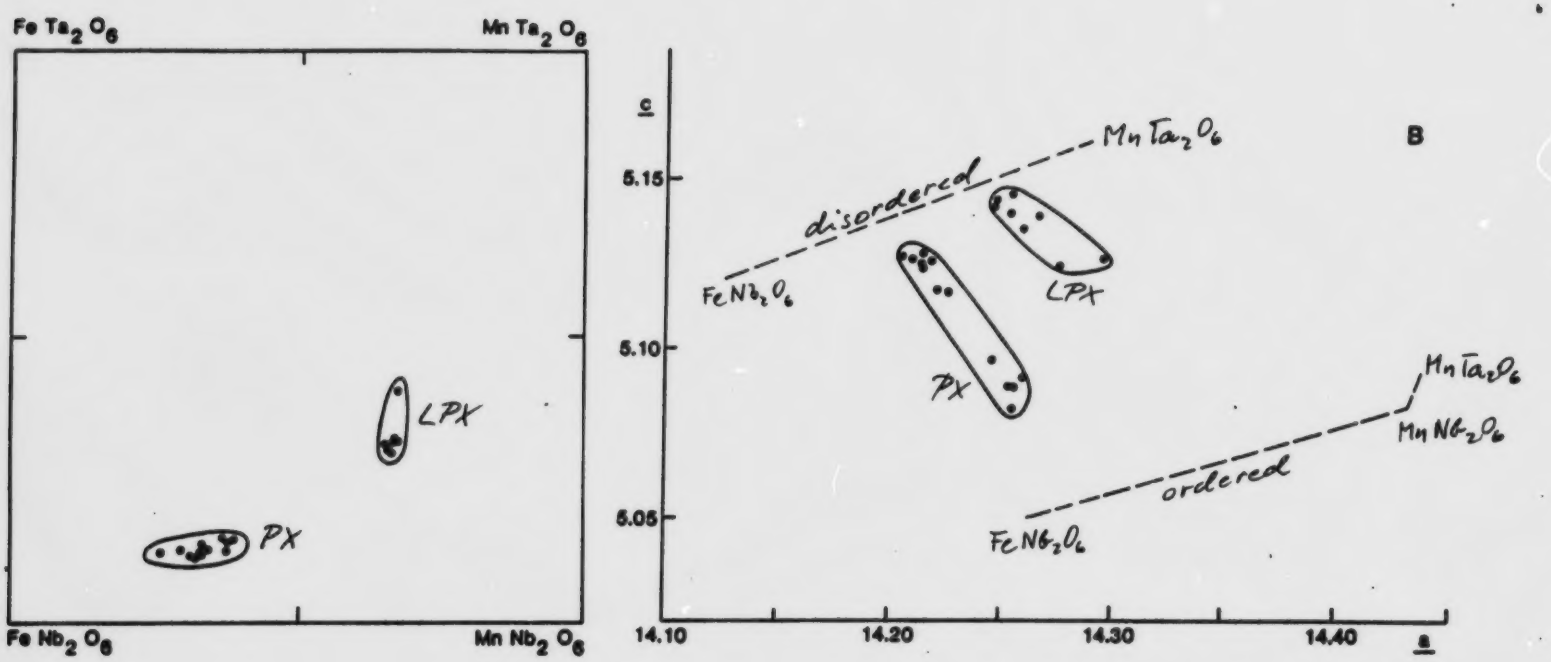

Figure 2. Composition and structural state of columbite from the PLEX pegmatites.

List of samples

LOWER PEGMATITE

LPX - 1 Typical muscovite of the replacement bodies, quartz and cleavelandite

LPX - 2 Pale garnet with albite and fine muscovite haloes in replacement muscovite

LPX - 3 Replacement muscovite with garnet and smoky quartz

LPX - 4 Columbite - tantalite from replacement muscovite pods

LPX - 5 Platy muscovite with garnet and quartz

LPX - 6 Columbite - tantalite from replacement muscovite pods

LPX - 7 Columbite - tantalite from replacement muscovite pods

LPX - 8 Columbite - tantalite from replacement muscpvite pods

LPX - 9 Columbite - tantalite from replacement muscovite pods

LPX -10 Mica from LPX 6 - LPX - 9

UPPER PEGMATITE

PX - 1 to PX - 5 Blocky K-feldspar from North (1) to South (5)

PX - 6 Quasi graphic muscovite in quartz and albite

PX - 7 Tourmaline and quartz and albite with muscovite and garnet near central outcrops

PX - 8 Platy muscovite from near core - two generations with albite and quartz

PX - 9 Smoky quartz from columbite - tantalite

PX - 10 Rose quartz from Quartz core

PX - 11 Cleavelandite, tourmaline and quartz from contact

PX - 12 Tourmaline and saccharoidal albite intergrowth

PX - 13 Cleavelandite

PX - 14 Tourmaline with cleavelandite and quartz

PX - 15 Tourmaline

PX - 16 Five columbite - tantalite plates from around tourmaline

PX - 17 Radial cluster of columbite - tantalite in quartz at tourmaline with zircon

PX - 18

PX - 19 Altered zircon in tourmaline

PX - 20 Radial zircons

PX - 21 Radial zircons

PX - 22 Four small columbite - tantalites from tourmaline

PX - 23 Yellow grain from giant columbite - tantalite

PX - 24 Giant columbite - tantalite

PX - 25 Columbite - tantalite

PX - 26 Big columbite - tantalite with tourmaline and cookeite-like mineral in leaching vugs

PX - 27 Three columbite - tantalite crystals from around giant columbite crystal

PX - 28 Altered arsenopyrite (Loellingite?)

PX - 29 Garnet and muscovite from central part of the dyke

PX - 30 Tourmaline and albite

PX - 31 Graphic tourmaline and garnet from north end

PX - 32 Garnet with albite, quartz, tourmaline and apatite

PX - 33 Garnet with tourmaline, albite and quartz

PX - 34 Garnet with tourmaline, albite and quartz

PX - 35 Tourmaline and graphic garnet with albite and quartz

PX - 36 Quartz and cleavelandite crystals in a vug

PG - 37 Lower schist with tourmalines

Atomic absorption analyses of K-feldspar

PROJECT: TCO YEAR: 19

NAME: K-FELDSPAR LOCALITY: MANITOBA SAMPLE NO.: PX-1

ADD'L MINERALS/REMARKS: WHITE PLUTON: TANCO BODY:

ANALYSIS BATCH: 186 STORAGE SHELF:

NO GEOGRAPHIC DATA ON FILE

TRICLINICITY: AN: N.D.

	WT %		WT %
TFE203	0.02	FE	0.01
CAO	0.02	CA	0.01
NA20	2.47	NA	1.83
K20	12.50	K	10.38
	WT %		PPM
LI20	0.002	LI	11.
RB20	0.457	RB	4180.
CS20	0.010	CS	93.
SRO	N.D.	SR	N.D.
BAO	N.D.	BA	N.D.
PBO	N.D.	PB	N.D.
	WT %		MOL %
K/RB	24.83		54.26
K/CS	1115.81		3792.51
K/BA	99.99		99.99
K/PB	99.99		99.99
RB/CS	44.95		69.89
RB/BA	99.99		99.99

	WT %			MOL %		
OR/AB/AN	84.89	14.99	0.12	76.82	23.07	0.10

TFE203 = TOTAL IRON AS FE203

99.99 OR 99999. DESIGNATE OXIDES OR ELEMENTS NOT DETERMINED

PROJECT: TCO YEAR: 19

NAME: K-FELDSPAR LOCALITY: MANITOBA SAMPLE NO.: PX-2

ADD'L MINERALS/REMARKS: WHITE PLUTON: TANCO BODY:

ANALYSIS BATCH: 186 STORAGE SHELF:

NO GEOGRAPHIC DATA ON FILE

TRICLINICITY: AN: N.D.

	WT %		WT %
TFE203	0.02	FE	0.01
CAO	0.05	CA	0.04
NA20	3.03	NA	2.25
K20	12.00	K	9.96
	WT %		PPM
LI20	0.003	LI	13.
RB20	0.284	RB	2600.
CS20	0.003	CS	31.
SRO	N.D.	SR	N.D.
BAO	N.D.	BA	N.D.
PBO	N.D.	PB	N.D.
	WT %		MOL %
K/RB	38.32		83.75
K/CS	3213.52		10922.44
K/BA	99.99		99.99
K/PB	99.99		99.99
RB/CS	83.87		130.42
RB/BA	99.99		99.99

	WT %			MOL %		
OR/AB/AN	81.35	18.36	0.29	72.08	27.66	0.25

TFE203 = TOTAL IRON AS FE203

99.99 OR 99999. DESIGNATE OXIDES OR ELEMENTS NOT DETERMINED

PROJECT: TCO YEAR: 19

NAME: K-FELDSPAR LOCALITY: MANITOBA SAMPLE NO.: PX-3

ADD'L MINERALS/REMARKS: WHITE PLUTON: TANCO BODY:

ANALYSIS BATCH: 186 STORAGE SHELF:

NO GEOGRAPHIC DATA ON FILE

TRICLINICITY: AN: N.D.

	WT %		WT %
TFE203	0.02	FE	0.01
CAO	0.01	CA	0.01
NA2O	3.15	NA	2.34
K2O	12.05	K	10.00
	WT %		PPM
LI2O	0.003	LI	16.
RB2O	0.227	RB	2080.
CS2O	0.006	CS	61.
SRO	N.D.	SR	N.D.
BAO	N.D.	BA	N.D.
PBO	N.D.	PB	N.D.
	WT %		MOL %
K/RB	48.09		105.12
K/CS	1639.91		5573.87
K/BA	99.99		99.99
K/PB	99.99		99.99
RB/CS	34.10		53.02
RB/BA	99.99		99.99

	WT %			MOL %		
OR/AB/AN	81.02	18.93	0.06	71.53	28.42	0.05

TFE203 = TOTAL IRON AS FE203

99.99 OR 99999. DESIGNATE OXIDES OR ELEMENTS NOT DETERMINED

PROJECT: TCO YEAR: 19

NAME: K-FELDSPAR LOCALITY: MANITOBA SAMPLE NO.: PX-4

ADD'L MINERALS/REMARKS: WHITE PLUTON: TANCO BODY:

ANALYSIS BATCH: 186 STORAGE SHELF:

NO GEOGRAPHIC DATA ON FILE

TRICLINICITY: AN: N.D.

	WT %		WT %
TFE203	0.02	FE	0.01
CAO	0.03	CA	0.02
NA20	3.28	NA	2.43
K20	11.80	K	9.80
	WT %		PPM
LI20	0.003	LI	14.
RB20	0.197	RB	1800.
CS20	0.006	CS	53.
SRO	N.D.	SR	N.D.
BAO	N.D.	BA	N.D.
PBO	N.D.	PB	N.D.
	WT %		MOL %
K/RB	54.42		118.95
K/CS	1848.28		6282.12
K/BA	99.99		99.99
K/PB	99.99		99.99
RB/CS	33.96		52.81
RB/BA	99.99		99.99

	WT %			MOL %		
OR/AB/AN	79.96	19.86	0.18	70.19	29.66	0.15

TFE203 = TOTAL IRON AS FE203

99.99 OR 99999. DESIGNATE OXIDES OR ELEMENTS NOT DETERMINED

PROJECT: TCO YEAR: 19

NAME: K-FELDSPAR LOCALITY: MANITOBA SAMPLE NO.: PX-5

ADD'L MINERALS/REMARKS: WHITE PLUTON: TANCO BODY:

ANALYSIS BATCH: 186 STORAGE SHELF:

NO GEOGRAPHIC DATA ON FILE

TRICLINICITY: AN: N.D.

	WT %		WT %
TFE203	0.02	FE	0.01
CAO	0.05	CA	0.04
NA20	2.88	NA	2.14
K20	12.05	K	10.00
	WT %		PPM
LI20	0.002	LI	8.
RB20	0.231	RB	2110.
CS20	0.005	CS	49.
SRO	N.D.	SR	N.D.
BAO	N.D.	BA	N.D.
PBO	N.D.	PB	N.D.
	WT %		MOL %
K/RB	47.41		103.63
K/CS	2041.52		6938.90
K/BA	99.99		99.99
K/PB	99.99		99.99
RB/CS	43.06		66.96
RB/BA	99.99		99.99

	WT %			MOL %		
OR/AB/AN	82.16	17.55	0.29	73.17	26.58	0.25

TFE203 = TOTAL IRON AS FE203

99.99 OR 99999. DESIGNATE OXIDES OR ELEMENTS NOT DETERMINED

Atomic absorption analyses of muscovite

PROJECT: TCO YEAR: 19

NAME: MUSCOVITE LOCALITY: MANITOBA SAMPLE NO.: PX-6

ADD'L MINERALS/REMARKS: QUASIGRAPHIC PLUTON: TANCO BODY:

ANALYSIS BATCH: 185 STORAGE SHELF:

NO GEOGRAPHIC DATA ON FILE

POLYTYPE:

	WT %		WT %
TFE203	2.620	FE	1.833
TIO2	N.D.	TI	N.D.
MNO	0.070	MN	0.054
MGO	0.280	MG	0.169
CAO	0.002	CA	0.001
NA20	0.960	NA	0.712
K20	9.690	K	8.044
LI20	0.250	LI	0.116
	WT %		PPM
RB20	0.354	RB	3240.
CS20	0.006	CS	58.
TL203	N.D.	TL	N.D.
BEO	0.005	BE	17.
GA203	N.D.	GA	N.D.

	WT %	MOL %
K/RB	24.83	54.27
K/CS	1386.94	4714.06
RB/CS	55.86	86.87
TIO2/FE203	99.990	99.990
TI/FE	99.990	99.990

TFE203 = TOTAL IRON AS FE203

99.99 OR 99999. DESIGNATE OXIDES OR ELEMENTS NOT DETERMINED

PROJECT: TCO YEAR: 19

NAME: MUSCOVITE LOCALITY: MANITOBA SAMPLE NO.: PX-7

ADD'L MINERALS/REMARKS: TOURM+QZ+AB+GAR PLUTON: TANCO BODY:

ANALYSIS BATCH: 185 STORAGE SHELF:

NO GEOGRAPHIC DATA ON FILE

POLYTYPE:

	WT %		WT %
TFE203	2.790	FE	1.951
TIO2	N.D.	TI	N.D.
MNO	0.030	MN	0.023
MGO	0.310	MG	0.187
CAO	0.010	CA	0.007
NA20	0.710	NA	0.527
K20	9.730	K	8.077
LI20	0.270	LI	0.125
	WT %		PPM
RB20	0.303	RB	2770.
CS20	0.005	CS	51.
TL203	N.D.	TL	N.D.
BEO	0.005	BE	17.
GA203	N.D.	GA	N.D.

	WT %	MOL %
K/RB	29.16	63.74
K/CS	1583.81	5383.23
RB/CS	54.31	84.46
TIO2/FE203	99.990	99.990
TI/FE	99.990	99.990

TFE203 = TOTAL IRON AS FE203

99.99 OR 99999. DESIGNATE OXIDES OR ELEMENTS NOT DETERMINED

PROJECT: TCO YEAR: 19

NAME: MUSCOVITE LOCALITY: MANITOBA SAMPLE NO.: PX-8A

ADD'L MINERALS/REMARKS: LARGE PLATES PLUTON: TANCO BODY:

ANALYSIS BATCH: 185 STORAGE SHELF:

NO GEOGRAPHIC DATA ON FILE

POLYTYPE:

	WT %		WT %
TFE203	2.350	FE	1.644
TI02	N.D.	TI	N.D.
MNO	0.040	MN	0.031
MGO	0.370	MG	0.223
CAO	0.010	CA	0.007
NA20	1.000	NA	0.742
K20	9.700	K	8.053
LI20	0.270	LI	0.125
	WT %		PPM
RB20	0.269	RB	2460.
CS20	0.003	CS	29.
TL203	N.D.	TL	N.D.
BEO	0.004	BE	15.
GA203	N.D.	GA	N.D.

	WT %	MOL %
K/RB	32.73	71.55
K/CS	2776.74	9437.86
RB/CS	84.83	131.91
TI02/FE203	99.990	99.990
TI/FE	99.990	99.990

TFE203 = TOTAL IRON AS FE203

99.99 OR 99999. DESIGNATE OXIDES OR ELEMENTS NOT DETERMINED

PROJECT: TCO YEAR: 19

NAME: MUSCOVITE LOCALITY: MANITOBA SAMPLE NO.: PX-88

ADD'L MINERALS/REMARKS: SMALL PLATES PLUTON: TANCO BODY:

ANALYSIS BATCH: 185 STORAGE SHELF:

NO GEOGRAPHIC DATA ON FILE

POLYTYPE:

	WT %		WT %
TFE203	2.220	FE	1.553
TI02	N.D.	TI	N.D.
MN0	0.030	MN	0.023
MG0	0.350	MG	0.211
CA0	0.002	CA	0.001
NA20	0.980	NA	0.727
K20	9.880	K	8.202
LI20	0.270	LI	0.125
	WT %		PPM
RB20	0.253	RB	2310.
CS20	0.003	CS	32.
TL203	N.D.	TL	N.D.
BE0	0.004	BE	14.
GA203	N.D.	GA	N.D.

	WT %	MOL %
K/RB	35.51	77.61
K/CS	2563.12	8711.78
RB/CS	72.19	112.25
TI02/FE203	99.990	99.990
TI/FE	99.990	99.990

TFE203 = TOTAL IRON AS FE203

99.99 OR 99999. DESIGNATE OXIDES OR ELEMENTS NOT DETERMINED

PROJECT: TCO YEAR: 19

NAME: MUSCOVITE LOCALITY: MANITOBA SAMPLE NO.: LPX-1

ADD'L MINERALS/REMARKS: REPLACEMENT BOD PLUTON: TANCO BODY:

ANALYSIS BATCH: 185 STORAGE SHELF:

NO GEOGRAPHIC DATA ON FILE

POLYTYPE:

	WT %		WT %
TFE203	2.650	FE	1.853
TI02	N.D.	TI	N.D.
MNO	0.270	MN	0.209
MGO	0.020	MG	0.012
CAO	0.010	CA	0.007
NA20	0.770	NA	0.571
K20	9.660	K	8.019
LI20	0.270	LI	0.125
	WT %		PPM
RB20	0.826	RB	7550.
CS20	0.013	CS	118.
TL203	N.D.	TL	N.D.
BEO	0.006	BE	20.
GA203	N.D.	GA	N.D.

	WT %	MDL %
K/RB	10.62	23.22
K/CS	679.61	2309.91
RB/CS	63.98	99.49
TI02/FE203	99.990	99.990
TI/FE	99.990	99.990

TFE203 = TOTAL IRON AS FE203

99.99 OR 99999. DESIGNATE OXIDES OR ELEMENTS NOT DETERMINED

PROJECT: TCO YEAR: 19

NAME: MUSCOVITE LOCALITY: MANITOBA SAMPLE NO.: LPX-3

ADD'L MINERALS/REMARKS: REPLACE/GARN,QZ PLUTON: TANCO BODY:

ANALYSIS BATCH: 185 STORAGE SHELF:

NO GEOGRAPHIC DATA ON FILE

POLYTYPE:

	WT %		WT %
TFE203	2.630	FE	1.840
TIO2	N.D.	TI	N.D.
MNO	0.090	MN	0.070
MGO	0.090	MG	0.054
CAO	0.001	CA	0.001
NA2O	0.760	NA	0.564
K2O	10.130	K	8.410
LI2O	0.240	LI	0.111
	WT %		PPM
RB2O	0.495	RB	4530.
CS2O	0.052	CS	490.
TL2O3	N.D.	TL	N.D.
BEO	0.004	BE	16.
GA2O3	N.D.	GA	N.D.

	WT %	MOL %
K/RB	18.56	40.58
K/CS	171.62	583.33
RB/CS	9.24	14.38
TIO2/FE2O3	99.990	99.990
TI/FE	99.990	99.990

TFE203 = TOTAL IRON AS FE2O3

99.99 OR 99999. DESIGNATE OXIDES OR ELEMENTS NOT DETERMINED

Electron microprobe analyses of garnet

A51LPX-5*

ION	ION WT. %	OXIDE	OXIDE WT. %	CATIONS PER 12. OXYGENS
Si^{4+}	17.01	SiO_2	36.40	2.98
Al^{3+}	11.01	Al_2O_3	20.80	2.01
Fe^{3+}	0.23	Fe_2O_3	0.33	0.02
Fe^{2+}	7.08	FeO	9.10	0.62
Mn^{2+}	26.02	MnO	33.60	2.33
Mg^{2+}	0.00	MgO	0.00	0.00
Ca^{2+}	0.21	CaO	0.30	0.03
O^{2-}	38.97			
TOTALS			100.53	8.00
TOTAL Fe AS FeO	7.31		9.40	0.65

OXYGEN, Fe^{2+}/Fe^{3+} DETERMINED BY STOICHIOMETRY

RATIOS

(MnO X 100) / (MnO + FeO): 78.68

FeO/MnO/(MgO X 10): 21.32/78.68/ 0.00

FeO/MnO/(CaO X 10): 19.92/73.52/ 6.56

A51LPX-2*

ION	ION WT. %	OXIDE	OXIDE WT. %	CATIONS PER 12. OXYGENS
Si^{4+}	16.97	SiO_2	36.30	2.99
Al^{3+}	11.01	Al_2O_3	20.80	2.02
Fe^{3+}	0.06	Fe_2O_3	0.09	0.01
Fe^{2+}	13.62	FeO	17.52	1.21
Mn^{2+}	19.59	MnO	25.30	1.76
Mg^{2+}	0.00	MgO	0.00	0.00
Ca^{2+}	0.14	CaO	0.20	0.02
O^{2-}	38.81			
TOTALS			100.21	8.00
TOTAL Fe AS FeO	13.68		17.60	1.21

OXYGEN, Fe^{2+}/Fe^{3+} DETERMINED BY STOICHIOMETRY

RATIOS

(MnO X 100) / (MnO + FeO): 59.08

FeO/MnO/(MgO X 10): 40.92/59.08/ 0.00

FeO/MnO/(CaO X 10): 39.09/56.45/ 4.46

A51LPX-3*

ION	ION WT. %	OXIDE	OXIDE WT. %	CATIONS PER 12. OXYGENS
Si^{4+}	17.06	SiO_2	36.50	2.99
Al^{3+}	11.12	Al_2O_3	21.00	2.03
Fe^{3+}	0.00	Fe_2O_3	0.00	0.00
Fe^{2+}	11.43	FeO	14.70	1.01
Mn^{2+}	21.76	MnO	28.10	1.95
Mg^{2+}	0.00	MgO	0.00	0.00
Ca^{2+}	0.21	CaO	0.30	0.03
O^{2-}	39.02			
TOTALS			100.60	8.00

OXYGEN, Fe^{2+}/Fe^{3+} DETERMINED BY STOICHIOMETRY

RATIOS

(MnO X 100) / (MnO + FeO): 65.65

FeO/MnO/(MgO X 10): 34.35/65.65/ 0.00

FeO/MnO/(CaO X 10): 32.10/61.35/ 6.55

A52PX7G*

ION	ION WT. %	OXIDE	OXIDE WT. %	CATIONS PER 12. OXYGENS
Si^{4+}	17.06	SiO_2	36.50	3.00
Al^{3+}	11.06	Al_2O_3	20.90	2.02
Fe^{3+}	0.00	Fe_2O_3	0.00	0.00
Fe^{2+}	19.20	FeO	24.70	1.70
Mn^{2+}	14.17	MnO	18.30	1.27
Mg^{2+}	0.00	MgO	0.00	0.00
Ca^{2+}	0.07	CaO	0.10	0.01
O^{2-}	38.93			
TOTALS			100.50	7.99

OXYGEN, Fe^{2+}/Fe^{3+} DETERMINED BY STOICHIOMETRY

RATIOS

(MnO X 100) / (MnO + FeO): 42.56

FeO/MnO/(MgO X 10): 57.44/42.56/ 0.00

FeO/MnO/(CaO X 10): 56.14/41.59/ 2.27

A55G*

ION	ION WT. %	OXIDE	OXIDE WT. %	CATIONS PER 12. OXYGENS
Si^{4+}	16.78	SiO_2	35.90	2.96
Al^{3+}	10.96	Al_2O_3	20.70	2.01
Fe^{3+}	0.77	Fe_2O_3	1.10	0.07
Fe^{2+}	6.93	FeO	8.91	0.61
Mn^{2+}	25.71	MnO	33.20	2.32
Mg^{2+}	0.00	MgO	0.00	0.00
Ca^{2+}	0.21	CaO	0.30	0.03
O^{2-}	38.75			
TOTALS			100.11	8.00
TOTAL Fe AS FeO	7.70		9.90	0.68

OXYGEN, Fe^{2+}/Fe^{3+} DETERMINED BY STOICHIOMETRY

RATIOS

(MnO X 100) / (MnO + FeO): 78.84

FeO/MnO/(MgO X 10): 21.16/78.84/ 0.00

FeO/MnO/(CaO X 10): 19.76/73.59/ 6.65

A56PX32-G*

ION	ION WT. %	OXIDE	OXIDE WT. %	CATIONS PER 12. OXYGENS
Si^{4+}	16.78	SiO_2	35.90	2.97
Al^{3+}	11.01	Al_2O_3	20.80	2.03
Fe^{3+}	0.47	Fe_2O_3	0.67	0.04
Fe^{2+}	15.24	FeO	19.60	1.35
Mn^{2+}	17.74	MnO	22.90	1.60
Mg^{2+}	0.00	MgO	0.00	0.00
Ca^{2+}	0.07	CaO	0.10	0.01
O^{2-}	38.67			
TOTALS			99.97	8.00
TOTAL Fe AS FeO	15.70		20.20	1.40

OXYGEN, Fe^{2+}/Fe^{3+} DETERMINED BY STOICHIOMETRY

RATIOS

(MnO X 100) / (MnO + FeO): 53.88

FeO/MnO/(MgO X 10): 46.12/53.88/ 0.00

FeO/MnO/(CaO X 10): 45.06/52.64/ 2.30

A57PX33G*

ION	ION WT. %	OXIDE	OXIDE WT. %	CATIONS PER 12. OXYGENS
Si^{4+}	17.11	SiO_2	36.60	2.99
Al^{3+}	11.12	Al_2O_3	21.00	2.02
Fe^{3+}	0.06	Fe_2O_3	0.09	0.01
Fe^{2+}	16.57	FeO	21.32	1.46
Mn^{2+}	16.96	MnO	21.90	1.51
Mg^{2+}	0.00	MgO	0.00	0.00
Ca^{2+}	0.14	CaO	0.20	0.02
O^{2-}	39.15			
TOTALS			101.11	8.00
TOTAL Fe AS FeO	16.63		21.40	1.46

OXYGEN, Fe^{2+}/Fe^{3+} DETERMINED BY STOICHIOMETRY

RATIOS

(MnO X 100) / (MnO + FeO): 50.67

FeO/MnO/(MgO X 10): 49.33/50.67/ 0.00

FeO/MnO/(CaO X 10): 47.15/48.43/ 4.42

A58G*

ION	ION WT. %	OXIDE	OXIDE WT. %	CATIONS PER 12. OXYGENS
Si^{4+}	17.15	SiO_2	36.70	2.98
Al^{3+}	11.38	Al_2O_3	21.50	2.06
Fe^{3+}	0.00	Fe_2O_3	0.00	0.00
Fe^{2+}	16.25	FeO	20.90	1.42
Mn^{2+}	17.04	MnO	22.00	1.51
Mg^{2+}	0.00	MgO	0.00	0.00
Ca^{2+}	0.14	CaO	0.20	0.02
O^{2-}	39.34			
TOTALS			101.30	7.99

OXYGEN, Fe^{2+}/Fe^{3+} DETERMINED BY STOICHIOMETRY

RATIOS

(MnO X 100) / (MnO + FeO): 51.28

FeO/MnO/(MgO X 10): 48.72/51.28/ 0.00

FeO/MnO/(CaO X 10): 46.55/49.00/ 4.45

A59PX35-G*

ION	ION WT. %	OXIDE	OXIDE WT. %	CATIONS PER 12. OXYGENS
Si^{4+}	17.01	SiO_2	36.40	2.98
Al^{3+}	11.17	Al_2O_3	21.10	2.04
Fe^{3+}	0.08	Fe_2O_3	0.12	0.01
Fe^{2+}	17.02	FeO	21.89	1.50
Mn^{2+}	16.34	MnO	21.10	1.46
Mg^{2+}	0.00	MgO	0.00	0.00
Ca^{2+}	0.14	CaO	0.20	0.02
O^{2-}	39.04			
TOTALS			100.81	8.00
TOTAL Fe AS FeO	17.10		22.00	1.51

OXYGEN, Fe^{2+}/Fe^{3+} DETERMINED BY STOICHIOMETRY

RATIOS

(MnO X 100) / (MnO + FeO): 49.08

FeO/MnO/(MgO X 10): 50.92/49.08/ 0.00

FeO/MnO/(CaO X 10): 48.66/46.90/ 4.45

N20-1

ION	ION WT. %	OXIDE	OXIDE WT. %	CATIONS PER 12. OXYGENS
Si^{4+}	16.87	SiO_2	36.10	2.98
Al^{3+}	10.96	Al_2O_3	20.70	2.02
Fe^{3+}	0.22	Fe_2O_3	0.31	0.02
Fe^{2+}	14.32	FeO	18.42	1.27
Mn^{2+}	18.82	MnO	24.30	1.70
Mg^{2+}	0.00	MgO	0.00	0.00
Ca^{2+}	0.07	CaO	0.10	0.01
O^{2-}	38.67			
TOTALS			99.93	8.00
TOTAL Fe AS FeO	14.54		18.70	1.29

OXYGEN, Fe^{2+}/Fe^{3+} DETERMINED BY STOICHIOMETRY

RATIOS

(MnO X 100) / (MnO + FeO): 56.88

FeO/MnO/(MgO X 10): 43.12/56.88/ 0.00

FeO/MnO/(CaO X 10): 42.13/55.58/ 2.29

Electron microprobe analyses of tourmaline

***** PLEX PEGMATITE TOURMALINES *****

	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9
NA2O	2.10	1.90	2.20	1.50	1.60	1.40	1.70	1.20	1.50
MGO	3.40	1.00	3.70	1.50	0.50	0.60	0.40	0.0	8.90
AL2O3	33.60	33.80	32.90	34.50	34.60	34.50	34.60	34.70	30.60
SIO2	35.50	35.10	34.70	34.60	34.80	34.60	35.30	35.30	36.10
K2O	0.0	0.04	0.0	0.0	0.10	0.10	0.0	0.0	0.20
CAO	0.20	0.10	0.30	0.0	0.0	0.0	0.0	0.0	2.30
TIO2	0.10	0.20	0.40	0.0	0.03	0.0	0.10	0.20	1.20
MNO	0.0	0.30	0.20	0.60	0.40	0.30	0.30	0.40	0.0
FEO	11.10	13.40	9.50	11.60	13.30	13.30	13.60	14.20	5.90
NA	0.332	0.304	0.355	0.242	0.257	0.226	0.271	0.192	0.232
MG	0.413	0.123	0.459	0.186	0.062	0.075	0.049	0.0	1.059
AL	3.229	3.292	3.226	3.386	3.383	3.391	3.356	3.370	2.878
SI	2.895	2.901	2.887	2.882	2.887	2.886	2.906	2.909	2.881
K	0.0	0.004	0.0	0.0	0.011	0.011	0.0	0.0	0.020
CA	0.017	0.009	0.027	0.0	0.0	0.0	0.0	0.0	0.197
TI4+	0.006	0.012	0.025	0.0	0.002	0.0	0.006	0.012	0.072
MN2+	0.0	0.021	0.014	0.042	0.028	0.021	0.021	0.028	0.0
FE2+	0.757	0.926	0.661	0.808	0.923	0.928	0.936	0.979	0.394
CATSUM	7.650	7.594	7.653	7.546	7.553	7.537	7.546	7.490	7.734
AN SUM	12	12	12	12	12	12	12	12	12

***** PLEX PEGMATITE TOURMALINES *****

	P-10	P-11	P-12	P-13
NA2O	1.90	2.00	2.20	1.90
MGO	0.30	0.40	0.40	0.50
AL2O3	34.40	34.10	34.10	33.90
SIO2	35.30	35.10	34.80	35.10
K2O	0.10	0.05	0.0	0.05
CAO	0.0	0.0	0.10	0.0
TIO2	0.20	0.20	0.0	0.0
MNO	0.40	0.30	0.30	0.30
FEO	13.80	14.50	14.10	14.10
NA	0.303	0.319	0.354	0.305
MG	0.037	0.049	0.049	0.062
AL	3.333	3.309	3.331	3.311
SI	2.903	2.890	2.885	2.909
K	0.010	0.005	0.0	0.005
CA	0.0	0.0	0.009	0.0
TI4+	0.012	0.012	0.0	0.0
MN2+	0.028	0.021	0.021	0.021
FE2+	0.949	0.998	0.977	0.977
CATSUM	7.575	7.605	7.626	7.591
AN SUM	12	12	12	12

Tourmaline p-1

SPECTRUM A52PX11*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.5402	1.56	0.12	NA2O	2.10	0.6644
MG KA	0.0131	2.05	0.08	MGO	3.39	0.8254
AL KA	0.1286	17.76	0.16	AL2O3	33.56	6.4518
SI KA	0.1177	16.61	0.14	SIO2	35.53	5.7972
CA KA	0.0012	0.13	0.01	CAO	0.18	0.0311
TI KA	0.0031	0.07	0.01	TIO2	0.12	0.0142
FE KA	0.0760	8.61	0.18	FEO	11.07	1.5109
O *		39.17				
TOTAL					85.95	15.2950

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Tourmaline P-2

SPECTRUM A52PX7T*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.4813	1.43	0.11	NA2O	1.93	0.6188
MG KA	0.0037	0.59	0.05	MGO	0.97	0.2393
AL KA	0.1298	17.88	0.16	AL2O3	33.78	6.5844
SI KA	0.1166	16.41	0.14	SIO2	35.12	5.8075
K KA	0.0025	0.03	0.01	K2O	0.04	0.0080
CA KA	0.0007	0.07	0.01	CAO	0.10	0.0176
TI KA	0.0050	0.11	0.01	TIO2	0.18	0.0225
MN KA	0.0073	0.23	0.03	MNO	0.30	0.0419
FE KA	0.0921	10.40	0.20	FEO	13.39	1.8512
O *		38.64				
TOTAL					85.80	15.1912

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Tourmaline P-3

SPECTRUM A53PX12*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.5612	1.61	0.13	NA2O	2.17	0.6988
MG KA	0.0143	2.21	0.08	MGO	3.67	0.9094
AL KA	0.1264	17.41	0.16	AL2O3	32.90	6.4531
SI KA	0.1155	16.23	0.13	SIO2	34.72	5.7780
CA KA	0.0019	0.20	0.02	CAO	0.28	0.0498
TI KA	0.0112	0.25	0.02	TIO2	0.41	0.0512
MN KA	0.0049	0.15	0.02	MNO	0.20	0.0279
FE KA	0.0655	7.40	0.17	FEO	9.52	1.3253
O *		38.40				
TOTAL					83.87	15.2936

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Tourmaline P-4

SPECTRUM A53PX14*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.3861	1.13	0.10	NA2O	1.53	0.4935
MG KA	0.0060	0.94	0.06	MGO	1.55	0.3852
AL KA	0.1332	18.25	0.16	AL2O3	34.47	6.7697
SI KA	0.1147	16.15	0.13	SIO2	34.56	5.7582
MN KA	0.0140	0.44	0.04	MNO	0.57	0.0803
FE KA	0.0800	9.02	0.19	FEO	11.60	1.6167
O *		38.36				
TOTAL					84.29	15.1037

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Tourmaline p-5

SPECTRUM A34-15-A*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.3876	1.15	0.10	NA2O	1.56	0.5004
MG KA	0.0021	0.33	0.05	MGO	0.54	0.1336
AL KA	0.1334	18.31	0.16	AL2O3	34.60	6.7614
SI KA	0.1155	16.29	0.13	SIO2	34.84	5.7783
K KA	0.0060	0.08	0.01	K2O	0.09	0.0192
TI KA	0.0007	0.02	0.01	TIO2	0.03	0.0033
MN KA	0.0092	0.29	0.03	MNO	0.38	0.0529
FE KA	0.0915	10.36	0.20	FEO	13.33	1.8484
O *		38.54				
TOTAL					85.36	15.0975

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Tourmaline p-6

SPECTRUM A54-15-B*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.3520	1.05	0.10	NA2O	1.41	0.4573
MG KA	0.0021	0.34	0.05	MGO	0.56	0.1403
AL KA	0.1332	18.27	0.16	AL2O3	34.52	6.7842
SI KA	0.1148	16.18	0.13	SIO2	34.62	5.7714
K KA	0.0077	0.10	0.01	K2O	0.12	0.0246
MN KA	0.0075	0.24	0.03	MNO	0.31	0.0433
FE KA	0.0914	10.35	0.20	FEO	13.31	1.8562
O *		38.33				
TOTAL					84.85	15.0774

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Tourmaline

P-7

SPECTRUM A55T*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.4269	1.27	0.10	NA2O	1.72	0.5478
MG KA	0.0016	0.26	0.04	MGO	0.43	0.1061
AL KA	0.1326	18.30	0.16	AL2O3	34.57	6.7056
SI KA	0.1164	16.50	0.14	SIO2	35.31	5.8109
TI KA	0.0024	0.05	0.01	TIO2	0.09	0.0110
MN KA	0.0079	0.25	0.03	MNO	0.33	0.0455
FE KA	0.0915	10.57	0.18	FEO	13.60	1.8722
O *		38.83				
TOTAL					86.04	15.0992

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Barnaloue p-8

SPECTRUM A56PX32T*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.2997	0.90	0.08	NA2O	1.21	0.3884
AL KA	0.1339	18.36	0.16	AL2O3	34.69	6.7447
SI KA	0.1170	16.50	0.14	SIO2	35.30	5.8245
TI KA	0.0041	0.09	0.01	TIO2	0.15	0.0184
MN KA	0.0086	0.27	0.03	MNO	0.35	0.0491
FE KA	0.0969	11.01	0.19	FEO	14.16	1.9539
O *		38.74				
TOTAL					85.87	14.9790

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Bowmalow (colwell) p-9

SPECTRUM A56PX37-T*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.3960	1.09	0.10	NA2O	1.46	0.4533
MG KA	0.0359	5.36	0.11	MGO	8.89	2.1181
AL KA	0.1162	16.21	0.15	AL2O3	30.64	5.7707
SI KA	0.1200	16.86	0.14	SIO2	36.06	5.7637
K KA	0.0097	0.12	0.02	K2O	0.15	0.0302
CA KA	0.0149	1.60	0.05	CAO	2.23	0.3845
TI KA	0.0320	0.72	0.03	TIO2	1.19	0.1435
FE KA	0.0399	4.57	0.12	FEO	5.87	0.7852
O *		39.99				
TOTAL					86.51	15.4492

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Tourmaline

P-10

SPECTRUM A57PX33C*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.4815	1.44	0.11	NA2O	1.94	0.6179
MG KA	0.0013	0.21	0.05	MGO	0.34	0.0835
AL KA	0.1325	18.18	0.16	AL2O3	34.35	6.6613
SI KA	0.1172	16.49	0.14	SIO2	35.29	5.8065
K KA	0.0040	0.05	0.01	K2O	0.06	0.0128
TI KA	0.0052	0.11	0.01	TIO2	0.19	0.0236
MN KA	0.0088	0.28	0.03	MNO	0.36	0.0497
FE KA	0.0955	10.73	0.20	FEO	13.80	1.8993
O *		38.84				
TOTAL					86.32	15.1546

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Tournaline

1-11

SPECTRUM A57PX33M*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.4913	1.47	0.12	NA2O	1.99	0.6351
MG KA	0.0014	0.23	0.05	MGO	0.38	0.0937
AL KA	0.1310	18.04	0.16	AL2O3	34.08	6.6190
SI KA	0.1164	16.40	0.14	SIO2	35.08	5.7820
K KA	0.0034	0.04	0.01	K2O	0.05	0.0106
TI KA	0.0059	0.13	0.02	TIO2	0.21	0.0264
MN KA	0.0072	0.23	0.03	MNO	0.29	0.0406
FE KA	0.1003	11.27	0.21	FEO	14.49	1.9976
O *		38.78				
TOTAL					86.58	15.2049

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Tourmaline

P-12

SPECTRUM A58T*

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.5370	1.61	0.12	NA2O	2.17	0.6964
MG KA	0.0014	0.22	0.04	MGO	0.37	0.0918
AL KA	0.1309	18.03	0.16	AL2O3	34.08	6.6597
SI KA	0.1155	16.28	0.13	SIO2	34.83	5.7760
CA KA	0.0008	0.08	0.01	CAO	0.12	0.0206
MN KA	0.0080	0.25	0.03	MNO	0.32	0.0454
FE KA	0.0970	10.94	0.21	FEO	14.08	1.9523
O *		38.54				
TOTAL					85.96	15.2423

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

SPECTRUM A59PX35-T* Tonnalwie p-13

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
NA KA	0.4791	1.43	0.12	NA2O	1.93	0.6210
MG KA	0.0018	0.29	0.05	MGO	0.48	0.1197
AL KA	0.1305	17.96	0.16	AL2O3	33.94	6.6269
SI KA	0.1166	16.40	0.14	SIO2	35.09	5.8142
K KA	0.0031	0.04	0.01	K2O	0.05	0.0097
MN KA	0.0083	0.26	0.03	MNO	0.34	0.0473
FE KA	0.0973	10.93	0.21	FEO	14.06	1.9488
O *		38.57				
TOTAL					85.89	15.1876

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Electron microprobe analyses of columbite

SPECTRUM N15-PX24A

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0096	0.28	0.03	TIO2	0.46	0.0815
MN KA	0.3236	4.05	0.14	MNO	5.23	1.0370
FE KA	0.3516	11.85	0.25	FEO	15.25	2.9872
NB LA	0.7318	46.04	0.54	NB2O5	65.86	6.9746
TA MA	0.1773	12.22	0.37	TA2O5	14.92	0.9504
O *		27.28				
TOTAL					101.72	12.0309

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

SPECTRUM N15-PX25 B

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0114	0.33	0.03	TIO2	0.55	0.0986
MN KA	0.3973	4.99	0.16	MNO	6.44	1.2991
FE KA	0.3066	10.37	0.24	FEO	13.34	2.6575
NB LA	0.7195	45.30	0.53	NB2O5	64.80	6.9784
TA MA	0.1762	12.14	0.37	TA2O5	14.82	0.9602
O *		26.83				
TOTAL					99.95	11.9936

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

SPECTRUM N15-PX25 B flux melt

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

tip of .xt

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0114	0.33	0.03	TIO2	0.55	0.0986
MN KA	0.3973	4.99	0.16	MNO	6.44	1.2991
FE KA	0.3066	10.37	0.24	FEO	13.34	2.6575
NB LA	0.7195	45.30	0.53	NB2O5	64.80	6.9784
TA MA	0.1762	12.14	0.37	TA2O5	14.82	0.9602
O *		26.83				
TOTAL					99.95	11.9936

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

SPECTRUM N15-PX26

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0126	0.37	0.03	TIO2	0.61	0.1096
MN KA	0.4527	5.65	0.17	MNO	7.30	1.4801
FE KA	0.2897	9.73	0.24	FEO	12.52	2.5078
NB LA	0.6874	43.74	0.51	NB2O5	62.57	6.7736
TA MA	0.2095	14.38	0.41	TA2O5	17.56	1.1435
O *		26.69				
TOTAL					100.56	12.0147

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

SPECTRUM MIS-PX27B

stubby lustrous interior

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0132	0.38	0.03	TIO2	0.64	0.1138
MN KA	0.4705	5.87	0.17	MNO	7.58	1.5213
FE KA	0.2862	9.60	0.24	FEO	12.35	2.4496
NB LA	0.6976	44.31	0.52	NB2O5	63.39	6.7946
TA MA	0.2086	14.30	0.41	TA2O5	17.46	1.1260
O *		26.95				
TOTAL					101.42	12.0053

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Lower Tex pg-1
c.+ in mesa.

SPECTRUM N16-LPX4A

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
MN KA	0.7625	9.11	0.22	MNO	11.76	2.6714
FE KA	0.1407	4.48	0.18	FEO	5.77	1.2931
NB LA	0.3977	27.79	0.37	NB2O5	39.76	4.8201
TA MA	0.5420	35.87	0.61	TA2O5	43.80	3.1940
O *		23.83				
TOTAL					101.08	11.9787

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Kolbeck Plex #5
e-4 in Mesic.

SPECTRUM N16-LPX4C

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT 3 LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0051	0.15	0.02	TIO2	0.24	0.0470
MN KA	0.7867	9.54	0.23	MNO	12.31	2.6943
FE KA	0.1458	4.73	0.18	FEO	6.08	1.3139
NB LA	0.4808	32.65	0.44	NB2O5	46.70	5.4548
SN LA	0.0028	0.26	0.04	SNO2	0.33	0.0341
TA MA	0.4313	28.87	0.55	TA2O5	35.26	2.4770
O *		24.74				
TOTAL					100.92	12.0212

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

SPECTRUM N16-PX16A

Sii x hyi c.-t

small xx, corrected

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
CA KA	0.0673	0.81	0.04	CAO	1.14	0.2921
TI KA	0.0131	0.38	0.03	TIO2	0.64	0.1149
MN KA	0.3668	4.63	0.14	MNO	5.98	1.2112
FE KA	0.2905	9.88	0.23	FEO	12.71	2.5427
NB LA	0.7204	45.20	0.53	NB2O5	64.66	6.9945
TA MA	0.1634	11.27	0.37	TA2O5	13.76	0.8953
O *		26.71				
TOTAL					98.87	12.0505

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

SPECTRUM N16-PX25A

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0183	0.53	0.04	TIO2	0.88	0.1564
MN KA	0.4161	5.21	0.15	MNO	6.73	1.3421
FE KA	0.3077	10.38	0.24	FEO	13.36	2.6294
NB LA	0.7204	45.34	0.53	NB2O5	64.87	6.9037
SN LA	0.0024	0.23	0.04	SNO2	0.30	0.0278
TA MA	0.1784	12.28	0.38	TA2O5	15.00	0.9603
O *		27.15				
TOTAL					101.13	12.0197

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

SPECTRUM N17LPX4B

Lorain Flux KB
c-t ins, mic.

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0060	0.17	0.02	TIO2	0.28	0.0548
MN KA	0.7817	9.46	0.23	MNO	12.22	2.6547
FE KA	0.1501	4.86	0.19	FEO	6.25	1.3410
NB LA	0.4843	32.85	0.44	NB2O5	46.99	5.4478
SN LA	0.0058	0.55	0.05	SNO2	0.70	0.0717
TA MA	0.4302	28.80	0.55	TA2O5	35.17	2.4527
O *		24.92				
TOTAL					101.62	12.0227

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Illeg. digit

SPECTRUM N17PX17A

small fragment from surface

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0128	0.37	0.03	TIO2	0.62	0.1108
MN KA	0.4114	5.15	0.16	MNO	6.65	1.3370
FE KA	0.3078	10.39	0.24	FEO	13.36	2.6510
NB LA	0.7156	45.13	0.53	NB2O5	64.57	6.9245
TA MA	0.1829	12.59	0.39	TA2O5	15.37	0.9917
O *		26.94				
TOTAL					100.58	12.0150

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

SPECTRUM N17PX24B

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0141	0.41	0.03	TIO2	0.68	0.1221
MN KA	0.4608	5.75	0.17	MNO	7.42	1.4967
FE KA	0.2935	9.85	0.24	FEO	12.67	2.5233
NB LA	0.6899	43.88	0.51	NB2O5	62.77	6.7563
TA MA	0.2098	14.39	0.41	TA2O5	17.58	1.1380
O *		26.84				
TOTAL					101.12	12.0364

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

flux #1, C-4

SPECTRUM N17PX27A

columnar c-t, lustrous interior

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0100	0.29	0.03	TIO2	0.48	0.0854
MN KA	0.4791	5.97	0.18	MNO	7.71	1.5453
FE KA	0.2976	9.98	0.25	FEO	12.84	2.5411
NB LA	0.6992	44.38	0.52	NB2O5	63.49	6.7901
TA MA	0.2053	14.09	0.40	TA2O5	17.21	1.1071
O *		27.01				
TOTAL					101.73	12.0689

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

no commits

SPECTRUM N18-PX16B

flux GS

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0147	0.43	0.03	TIO2	0.71	0.1257
MN KA	0.4086	5.12	0.16	MNO	6.61	1.3112
FE KA	0.3168	10.70	0.24	FEO	13.76 |	2.6947
NB LA	0.7354	46.14	0.54	NB2O5	66.00 |	6.9860
TA MA	0.1701	11.72	0.36	TA2O5	14.31	0.9111
O *		27.30				
TOTAL					101.40	12.0287

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

main sample, section

SPECTRUM N18-PX17B

plex #8

QUANTITATIVE EDS RESULTS
(ZAF CORRECTIONS VIA MAGIC V)

ELEMENT & LINE	K-RATIO	WEIGHT PERCENT	PRECISION 2 SIGMA	OXIDE FORMULA	OXIDE PERCENT	NO. OF CATIONS IN FORMULA
TI KA	0.0092	0.27	0.03	TIO2	0.45	0.0783
MN KA	0.3924	4.91	0.15	MNO	6.35	1.2569
FE KA	0.3223	10.88	0.25	FEO	13.99	2.7367
NB LA	0.7408	46.47	0.54	NB2O5	66.47	7.0276
TA MA	0.1706	11.75	0.36	TA2O5	14.35	0.9123
O *		27.33				
TOTAL					101.60	12.0118

NUMBER OF CATIONS CALCULATED ON BASIS OF 24 OXYGEN ATOMS.

* DETERMINED BY STOICHIOMETRY

Electron microprobe analysis of zircon

***** PLEX PEGMATITE ZIRCON *****

	55Z1
SIO2	28.90
CAO	0.60
FEO	0.30
ZRO2	59.90
HFO2	3.60
UO2	0.30
SI	3.876
CA	0.086
FE2+	0.034
ZR	3.917
HF	0.138
U4+	0.009
CATSUM	8.060
AN SUM	16

FINAL REPORT

Evaluation of rare-element pegmatites in NWT

COMPARISON AND EVALUATION OF THREE RARE-ELEMENT PEGMATITE POPULATIONS IN THE N.W.T.: SOUTHERN SLAVE PROVINCE, CENTRAL BAFFIN ISLAND, AND CHANTREY INLET.

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Indian and Northern Affairs Canada
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INTRODUCTION

The following sections of this report will deal with the individual pegmatite populations separately, from descriptive and economic viewpoints. Mutual comparison is presented in the concluding section.

SOUTHERN SLAVE PROVINCE

Three areas known to be populated of mineralized granitic pegmatites are dealt with here: the Yellowknife pegmatite field, the Aylmer-McKay Lakes area, and the Benjamin Lake area.

The Yellowknive field

The following characteristics of the Yellowknife field are excerpted from the unpublished Ph.D. theses of Dr. R.e. Meintzer and Dr. M.A. Wise. The first deals mainly with the granitoid suites of this region and the pegmatite populations as a whole, whereas the other is aimed specifically at the Nb,Ta,Sn-bearing mineralization of the pegmatites.

Regional geology

The Yellowknife pegmatite field lies within the extreme southwestern portion of the Archean Slave Structural Province of the Canadian Shield (Figure 2). The province, which is underlain by Late Archean rocks (3.0 - 2.5 Ga), has remained relatively stable since the close of the Archean era, except for minor faulting, folding and local intrusions during the early Proterozoic. The geology of the province has been documented by McGlynn and Henderson (1972), McGlynn (1977) and recently summarized by Padgham (1985).

The pegmatite field is underlain largely by granitoids and metasedimentary rocks and to a lesser extent by metavolcanic and gabbroid/dioritoid rocks (Figure 3). A thick sequence of metavolcanics and metasedimentary rocks comprises the supracrustal rocks of the Yellowknife Supergroup. The metavolcanic rocks are dominantly andesite, dacite and basalt flows which outcrop in an arcuate belt in the northwestern portion of the field and along the edge of folded metasediments in the west. The metasedimentary rocks consist largely of a thick sequence of interbedded graywacke-mudstone turbidites. The entire sequence of Yellowknife Supergroup rocks has been complexly folded, and regionally metamorphosed (greenschist to middle amphibolite facies). This low pressure metamorphism generated quartz-biotite schists and hornfels of amphibolite facies which contain conspicuous nodules of cordierite and, less commonly, andalusite.

Late Archean syntectonic and late-tectonic rocks of tonalitic, granodioritic and granitic compositions intruded the supracrustal and basement rocks at various times, and in part contributed to the complex folding of the metasediments. In addition, these late intrusions generated contact-

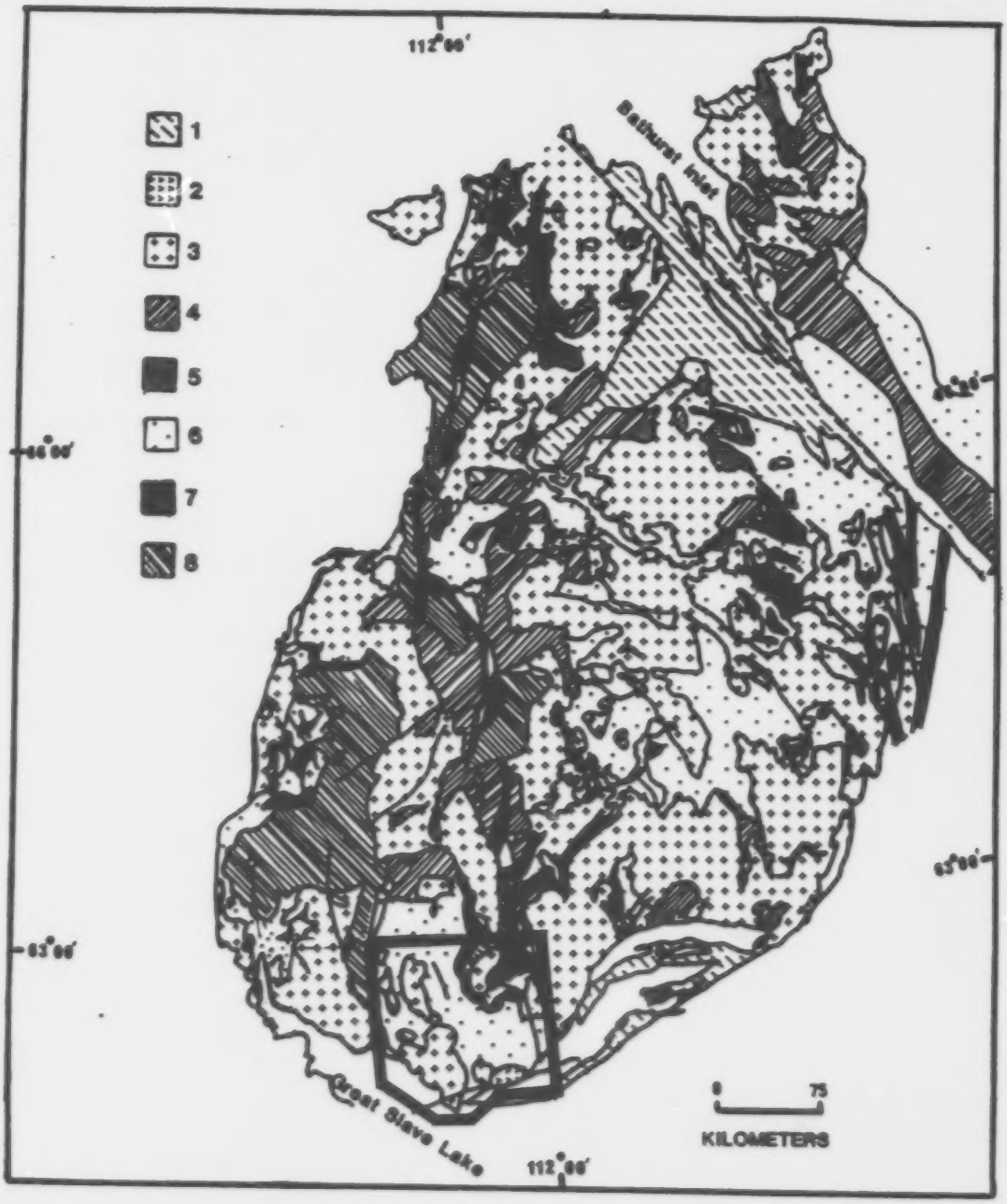

Figure 1: General geology map of the Slave Structural Province. The Yellowknife pegmatite field is outlined. Major rock units are numbered as follows: 1) Proterozoic cover rocks; 2) Proterozoic metamorphic and intrusive rocks; 3) Granitoid intrusions; 4) Migmatite; 5) Dominantly felsic volcanic belts; 6) Metasedimentary rocks, mainly turbidites; 7) Dominantly basaltic volcanic belts; 8) Metamorphic and intrusive rocks including pre-Yellowknife Supergroup granitoid rocks. Map modified after Padgham (1985).

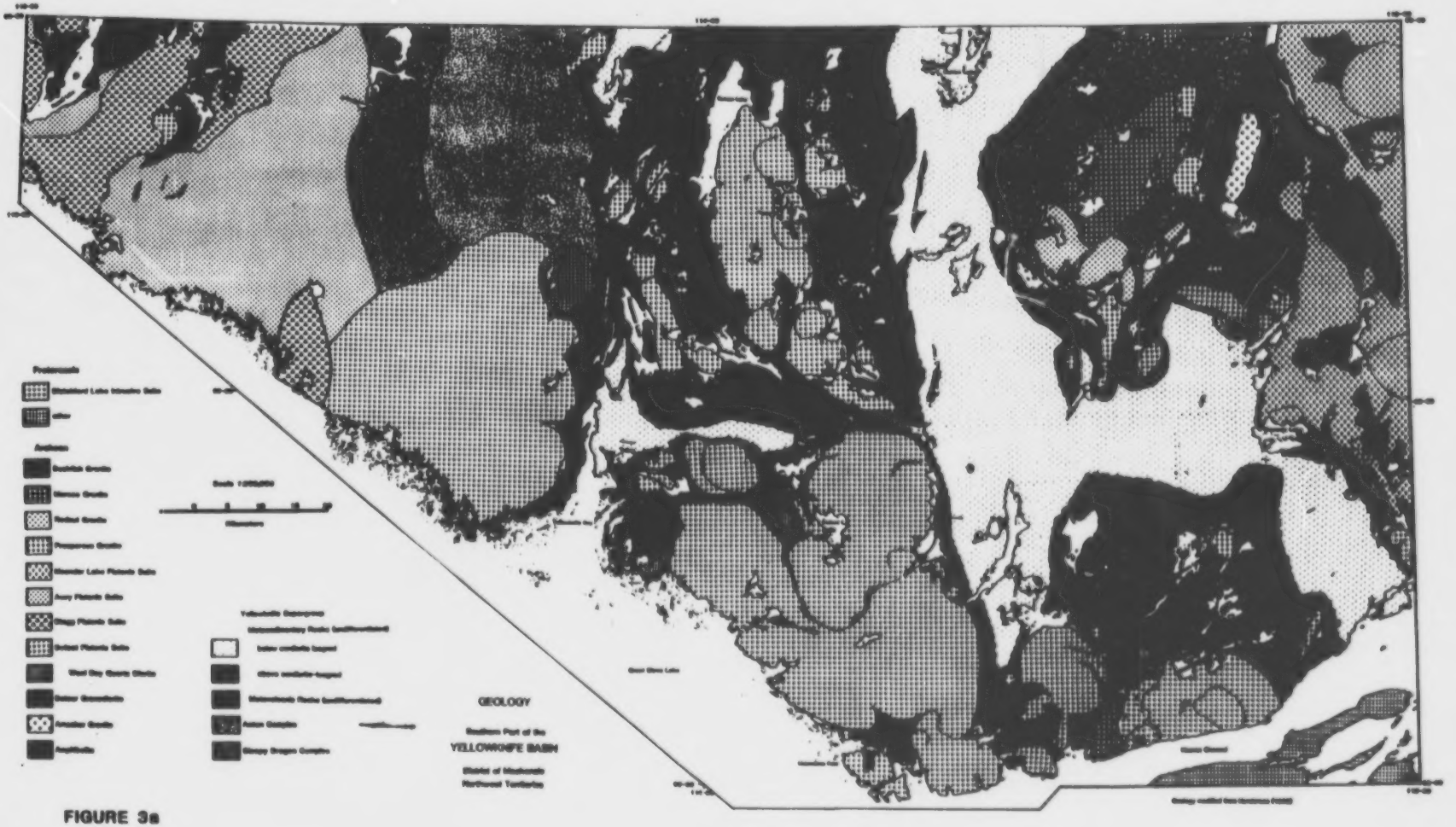
GEOLOGY
Southern Part of the
YELLOWKNIFE BASIN
District of Mackenzie
Northwest Territories

FIGURE 3a

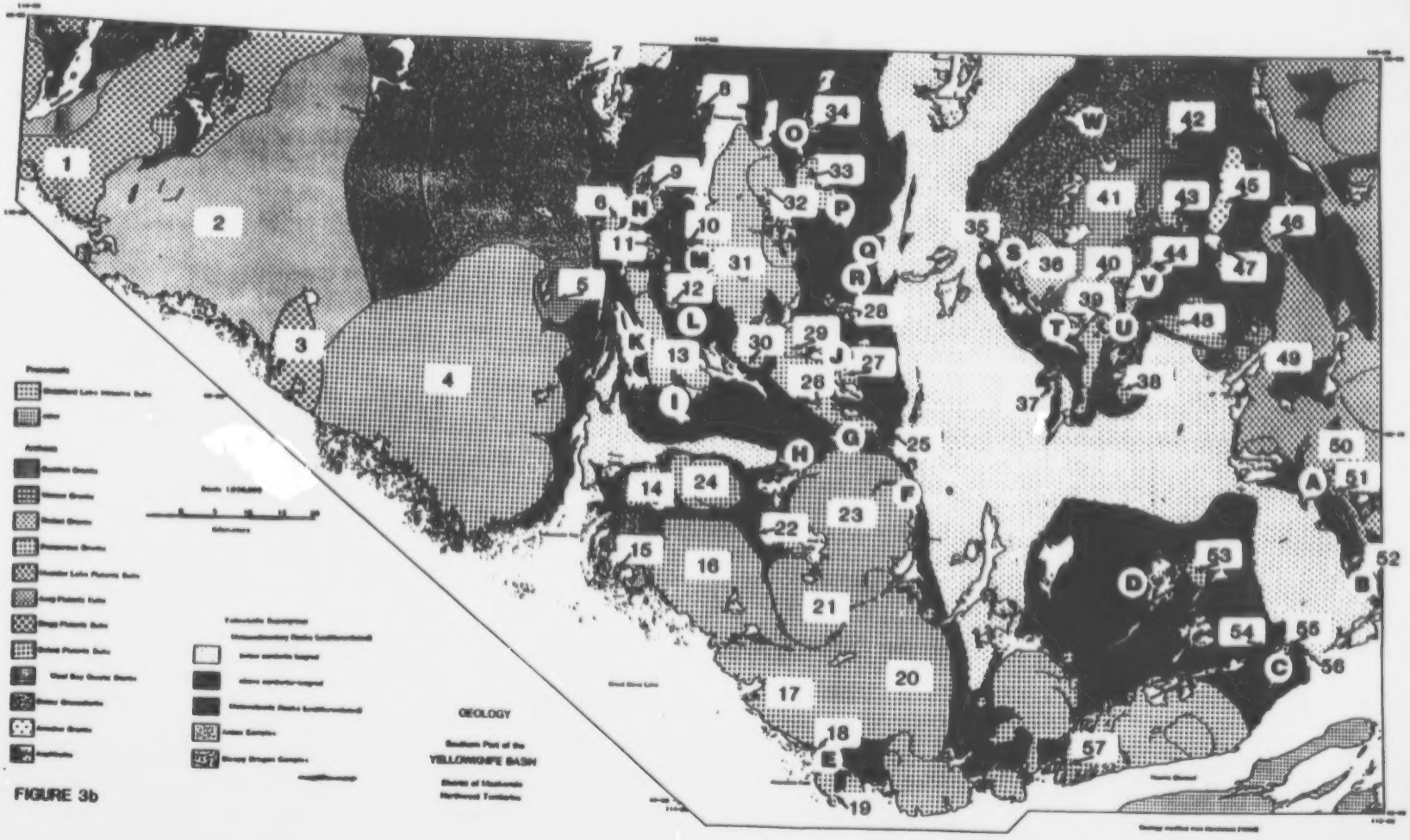
GEOLOGY
Southern Part of the
YELLOWKNIFE BASIN
District of Mackenzie
Northwest Territories

FIGURE 3b

PLUTONS (superscripts indicate lithodemic unit):

1. Frank Channel[4]
2. North Arm[5]
3. Trout Rock[4]
4. Western[3]
5. Duckfish[10]
6. Quyta[5]
7. Rocky[7]
8. Crapaud[3]
9. Neck[7]
10. Staple[7]
11. Drygeese[7]
12. Alexie[7]
13. Prosperous[7]
14. Mason[3]
15. Wool Bay[3]
16. Moose[3]
17. Black Fly[3]
18. Hare[7]
19. Matonabbee[7]
20. Hearne[3]
21. Defeat-South[3]
22. Defeat[3]
23. Harding[3]
24. Jennejohn[3]
25. Frog[7]
26. Cameron[7]
27. Hidden[7]
28. Scott[7]
29. Sparrow[7]
30. Prelude[7]
31. Duncan-West[7]
32. Duncan-East[7]
33. Wedge[7]
34. Prestige[7]
35. Ross Lake[1]
36. Redout[8]
37. Donor[7]
38. Beaulieu[3]
39. Horse Fly[5]
40. Ross River[5]
41. Morose[9]
42. Abedjah[7]
43. Goon[7]
44. Turnback[5]
45. Amacher[2]
46. Old Grump[6]
47. Two Bug[7]
48. Birch[5]
49. Desperation[6]
50. Eastern[6]
51. McDade[7]
52. Doubling[5]
53. Buckham[7]
54. McDuff[7]
55. Faulkner[3]
56. Beaver[3]
57. Camp[6]

[1] - Sleepy Dragon Complex
[2] - Amacher Granite
[3] - Defeat Plutonic Suite
[4] - Stagg Plutonic Suite
[5] - Awry Plutonic Suite
[6] - Meander Lake Plutonic Suite
[7] - Prosperous Granite
[8] - Redout Granite
[9] - Morose Granite
[10] - Duckfish Granite

PEGMATITE GROUPS/SERIES:

A - Tanco Lake Group
B - Doulbling Lake Group
C - Faulkner Lake Series
D - Buckham Lake Group
E - Great Slave Lake Group
F - Harding Lake Series
G - Reid Lake Group
H - Upland Lake Series
I - Highill Lake Group
J - Sparrow-Thompson-Hidden Lakes Group
K - Prosperous Lake Group
L - Petey Lake Series
M - Circle Lake Series
N - Short Point Lake Group
O - Lamoureux Lake Group
P - Blaisdell Lake Group
Q - Sproule Lake Series
R - Harald Lake Group
S - Upper Ross Lake Group
T - Detour Lake Series
U - Bug Group
V - Turnback Lake Group
W - Sleepy Dragon Lake Series

FIGURE 3: Geologic map of the Yellowknife - Hearne Lake map area. A) geologic map, B) index map for the geologic map, indicating individual plutons and pegmatite groups/series as indicated above. Geology modified after Henderson (1985)

metamorphic effects which were superimposed on earlier metamorphic assemblages, producing aureoles of cordierite, andalusite and sillimanite around the plutons. Several of the biotite-muscovite granite plutons contain pegmatitic phases, and are accompanied by pegmatite bodies which intrude the schists of the Yellowknife Supergroup within the contact aureole surrounding the pluton.

The pegmatite field is subdivided into four geographical areas for ease of discussion: southeastern, northeastern, northwestern and southwestern (Figure 4). These areas may be delineated by two imaginary lines: one originates at the western shore of Gordon Lake and extends southward to Hearne Channel, just west of Francois Bay; the second line extends westward from the south shore of Desperation Lake to the south shore of Harding Lake, onward to the mouth of Yellowknife Bay.

The areal distribution locally results in mineralogical and geochemical zoning of pegmatite bodies around their parent intrusion. Regional zonation of pegmatites around granites is suggested up to well-developed in different parts of the northeastern and northwestern parts of the field (e.g., Hutchinson, 1955a), but absent in the southeastern and southwestern regions.

The distribution of pegmatites within the immediate vicinity of granitic intrusions is controlled by many structural features including different types of fracture sets, bedding planes, foliation, schistosity and preexisting intrusive contacts (Kretz, 1968).

The pegmatites vary from narrow dikes to large, irregular shaped, homogeneous bodies lacking internal zonation, to complex dikes showing well-developed internal zonation, replacement units and extensive rare-element mineralization.

- -

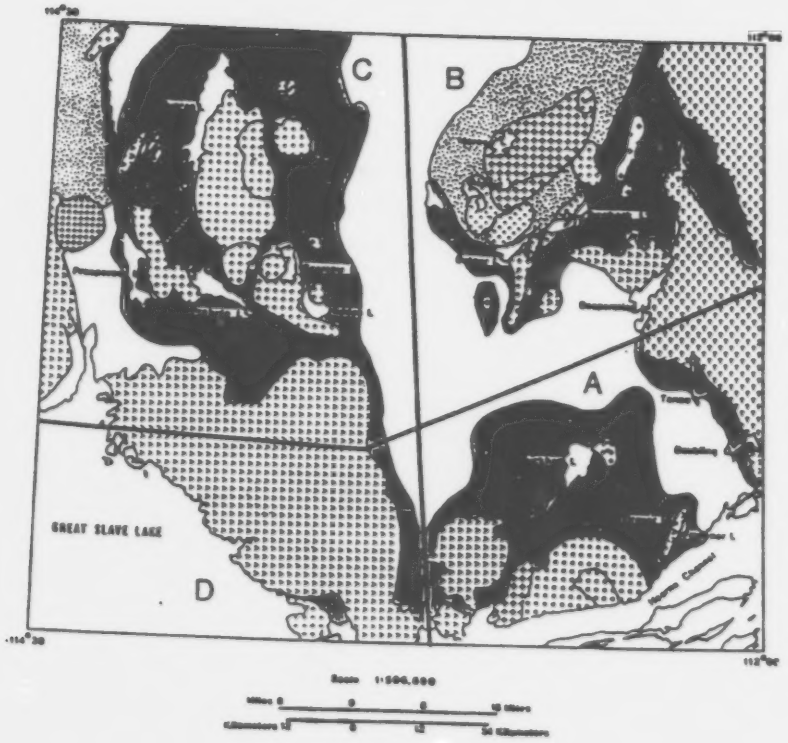

Figure 3: Geographical subdivision of the Yellowknife pegmatite field. Geographical areas for this study are designated by letters A-D. A) southeastern, B) northeastern, C) northwestern and D) southwestern.

Economic Considerations

Introduction

The Yellowknife pegmatite field is characterized overall by an association of Li, (Rb), Be, Nb/Ta, (Sn), B, (P), (F) mineralization.[1] Of those elements, pegmatite deposits contribute significantly to the worldwide supplies of all, but B, P, and F. In addition, pegmatites contribute significantly to the supply of feldspar, mica, and gemstones. Finally, Rb and Cs are derived solely from pegmatites, although Carrico and Hedrick (1985) note that future production may come from the processing of potash rock.

Within the Yellowknife field, the mineralization varies within and between pegmatite group/series, so the aim of this part shall be to review the geochemical potential of the field in general; the potential of the individual groups/series; and the possibilities of further exploration in selected areas.

Geochemical Potential of the Field

Geochemical potential of individual pegmatite groups/series

The Bighill Lake group is characterized by an Li, Be, Nb/Ta, (B) assemblage. Be attains its greatest accumulation in the dikes of the FERN swarm with lesser accumulations in the more evolved dikes of the swarm. Li concentration is greatest in dikes of the BIG and NITE swarms,

[1] Parentheses are used to denote lower abundance and the slash separates pairs of elements with the meaning that Nb/Ta means Nb>Ta.

where it reaches economic levels. Nb/Ta is concentrated with varying ratios in the BIG, MINT, and NITE swarms, but appears to be more disseminated in the ODIN swarm.

The Blaisdell Lake group is characterized by an Li, Be, Nb/Ta, (Sn), B assemblage. Li is accumulated in economic grades in the VO swarm and Be attains locally high concentrations in the BILL swarm. Nb/Ta mineralization becomes concentrated with increasing fractionation of the dikes and is predominantly Nb>Ta. Sn concentration is negligible.

The highly fractionated Buckham Lake group contains an assemblage of Li, Be, Nb/Ta, Sn, P. Li is concentrated throughout the group, but Nb/Ta and Sn are mostly concentrated in the LIT swarm and MAC pegmatite. Be is present throughout the group and montebrasite occurs in several dikes in small quantities.

The assemblage of the Bug group consists of (Be) only in meager and uneconomic quantities.

The highly fractionated Circle Lake series contains an assemblage of Li, (Rb), Be, Ta-Nb, (Sn), (Zr), B, P, (F). In the dikes of this series, Li is not present as spodumene, but has been concentrated as elbaite, montebrasite-amblygonite, and mixed lithian muscovite/lepidolite. Mineralization potential is greatest in the RIBER dike and, depending on the form of the bulbous body at depth, may warrant further exploration. As noted in the descriptive section, the dike has been assessed for Be and gemstone potential. Sheet mica is an additional possible resource.

Characterized by an assemblage of B only, the Detour Lake series displays no economic potential.

An assemblage of Li, (Be), Nb/Ta characterizes the Doubling Lake series. Economic grades of Li mineralization are present and sparse Nb/Ta mineralization contains Nb>Ta.

Although reportedly having Be in its assemblage, the observed assemblage for the Great Slave Lake group comprises only (B).

The Faulkner Lake series contains an assemblage of Li, Be, Nb/Ta, (Sn), P with economic concentrations of Li and Nb/Ta and appreciable quantities of montebrasite. Sn is most common in the TAN swarm and BIG HILL dike and Be has been identified in all dikes, but the those of the TAN swarm.

Uneconomical concentrations of (Li),(Be),(Nb/Ta) are present in the Harald Lake group.

The Harding Lake series contains an assemblage of Li, Be, Ta-Nb, (P). With economic concentrations of Li, the series contains one of the few assemblages with a distinctly Ta>Nb character.

A B, (Be) assemblage characterizes the Lamoureux Lake group. Low levels of fractionation dictate against economic concentrations of the elements.

The widespread Petey Lake series contains an assemblage of Be, (Nb-Ta), B, (P). The more rare-alkali fractionated dikes contain the few occurences of visible Nb-Ta mineralization and Be reaches economic proportions in the evolved dikes of the DIKE swarm.

The poorly populated Prosperous Lake group contains a Be, (B) assemblage with limited potential for economic development.

The Reid Lake group comprises a Li, Be, Nb/Ta, (P) assemblage with economic deposits of Li. Nb-Ta mineralization has variable Nb/Ta ratios

and appears to be erratically developed. Minor montebrasite-amblygonite occurs in the ANN & BOA swarm.

The Short Point Lake group represents a B assemblage with no economic potential.

The Sleepy Dragon Lake series consists of a (Be) assemblage, but the paucity of Be and the apparently low level of rare-element fractionation dictate against economic potential.

The large Sparrow-Thompson-Hidden Lakes group comprises a Li, Be, Nb-Ta, Sn, B, (P) assemblage with Be concentrated in dikes with a low degree of rare-alkali fractionation (CASPER) and in dikes with increasing levels of rare-alkali fractionation. Li concentration reaches economic levels in the more fractionated pegmatites, as does Nb-Ta and Sn mineralization. Montebrasite occurs in small quantities.

The Sproule Lake series of highly fractionated dikes comprises an assemblage of Li,Be, Nb-Ta, Sn, (B), and P. Lithium mineralization is not extensive as spodumene, but montebrasite occurs in many dikes. Nb-Ta and Sn mineralization is well-developed.

The spodumene-rich Tanco Lake group comprises an assemblage of Li, (Be), Nb/Ta, (P). Be appears to be erratically distributed as, too, Nb-Ta mineralization. Montebrasite is limited to three dikes in the JO and THOR ECHO swarms.

No economic potential is foreseen in the barren dikes of the Turnback Lake group.

The Upland Lake series comprises an assemblage of Li, (Be), (Nb/Ta) with little apparent economic concentration of rare-element minerals.

The Upper Ross Lake group contains an assemblage of Li, Be, Nb-Ta, (Sn), B, (P). The economic potential of Li is limited to the few spodumene-bearing dikes along the western fringe of the group, while concentration of Nb-Ta with variable Nb/Ta ratios appears to be localized in less rare-alkali fractionated dikes. Be mineralization is widespread, but Sn is very limited to highly fractionated dikes and P is localized as triphylite and beusite with no montebrasite observed.

Geochemical Indicators

As the type and degree of rare-element mineralization is largely a function of the level of fractionation attained by the pegmatite melt, geochemical indicators based on fractionation trends of rare-elements have been developed to ascertain the economic potential of pegmatite deposits. An extensive discussion of the various indicators is given by Trueman and Černý (1982).

In an attempt to further characterize the potential of the Yellowknife field, several indicators specifically applied to economic assessment are discussed below in relation to Yellowknife data.

Absolute concentrations of Li, Rb, Cs in K-feldspar and muscovite.

Based on data collected on the contents of Li, Rb, and Cs in K-feldspar and muscovite, Gordiyenko (1971) characterized five different pegmatite types based on the content of those elements. The pegmatite types characterized were described as: IA - barren feldspathic pegmatite; IB - barren feldspathic pegmatite of rare-metal provinces; II - muscovite-feldspar pegmatite with Be + Nb-Ta mineralization; III - spodumene-bearing pegmatites with Li, Be, Ta-Nb, Sn; and IV - spodumene-lepidolite pegmatite with Li, Cs, Ta-Nb, Be, and Sn.

Plotted on Figure 1 are the average contents of Li, Rb, and Cs of K-feldspar and platy muscovite from four dikes:

RIBER - amblygonite subtype of the complex type, with Li, Be, Nb-Ta, Sn, Zr, (P) mineralization;

PEG-93 - beryl-columbite-phosphate subtype of the beryl type with Be, Nb-Ta, (P) mineralization;

TAN-2 - spodumene subtype of the complex type with Li, Be, Nb-Ta, (Sn) mineralization; and

NITE-C - albite-spodumene type with Li, Be, Nb-Ta mineralization.

With the exception of the RIBER pegmatite, assignments of type correspond with field and laboratory observations on the Rb and the Cs diagrams in all cases but for muscovite for PEG-93. The Li diagram gives erroneous classification for two-thirds of the values. RIBER is variably classified as a spodumene or spodumene-lepidolite dike in the Rb and Cs diagrams, as a barren rare-metal dike in regards to K-feldspar Li contents, but spodumene-bearing in regards to the Li contents of muscovite.

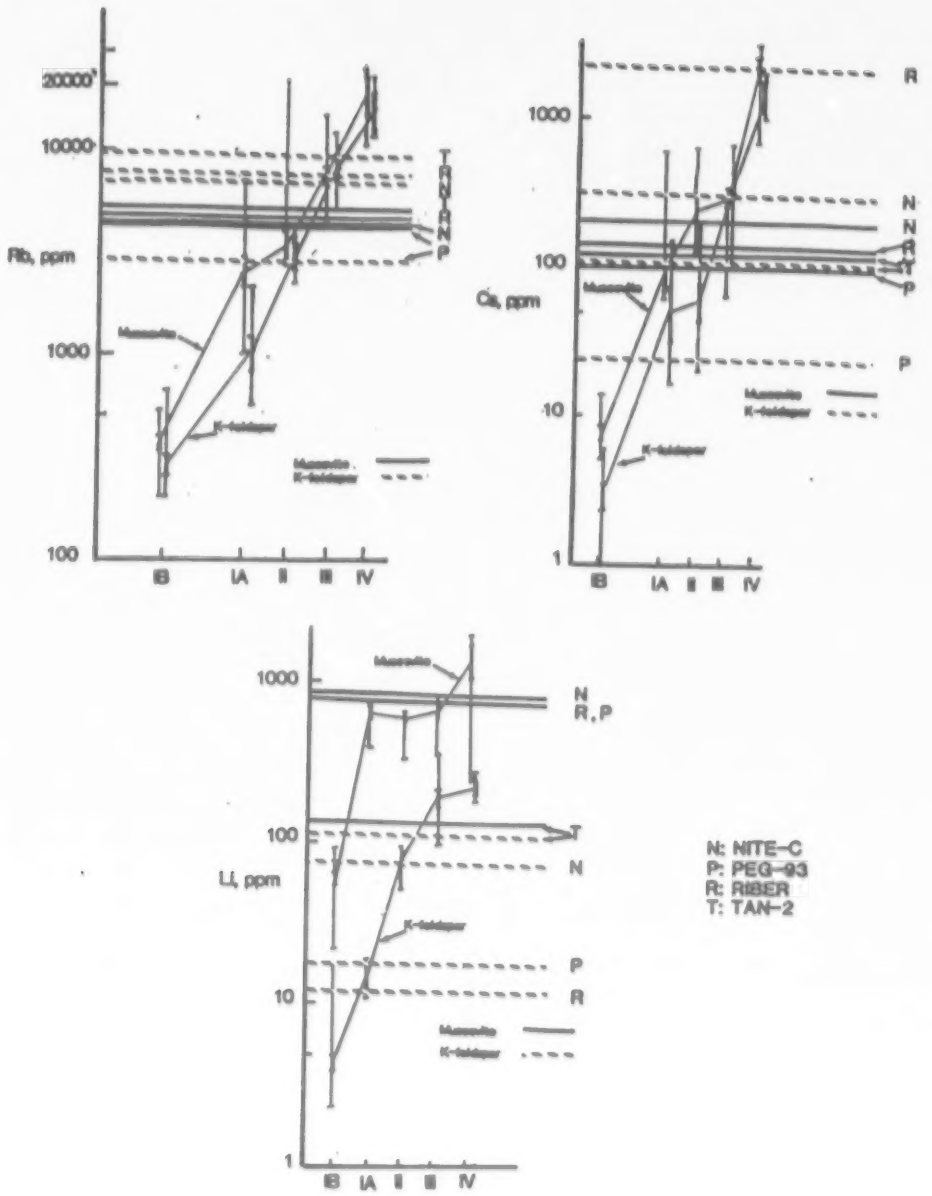

Figure 1: Plot of Li, Rb, and Cs contents of K-feldspar and muscovite in the geochemical indicator plot of Gordiyenko (1971). IA - barren feldspathic pegmatite; IB - feldspathic pegmatite or rare-metal provinces; II - muscovite-feldspar pegmatite with Be + Nb-ta mineralization; III - spodumene-bearing pegmatites with Li, Be, Ta-Nb, Sn; and IV - spodumene-lepidolite pegmatite with Li, Cs, Ta-Nb, Be, and Sn.

K/Cs vs. Na_2O indicator diagram.

Subsequent to the development of the diagrams used above, Gordiyenko (1976) developed additional indicator plots based on the Cs and Na contents of K-feldspar, contending that variation of these elements provided an accurate interpretation of pegmatite types.

Figure 2 and Figure 3 display the values observed within the Yellowknife field using Gordiyenko's (1976) fields in the K/Cs vs. Na_2O diagrams wherein the fields are:

I - Cs-bearing series of the rare-metal type of pegmatite (Cs-type);

a, b, c - pollucite-bearing dikes,

d - rare-metal-bearing dikes without pollucite,

e - barren dikes.

II - Spodumene-bearing series of the rare-metal type of pegmatite (Li-type);

a - spodumene-bearing dikes,

b - beryl-bearing dikes,

c - barren dikes.

III - Mica-type pegmatites;

Within the eastern section of the NW area, a high proportion K-feldspar from spodumene-bearing dikes fall into the beryl-bearing field and a few data points in the Cs-bearing fields, Id and Ie.

Data points of the southern section populate the spodumene- and beryl-bearing fields of the Li-type dikes, but a population of beryl-bearing dikes also falls in the Cs-type field, Ie.

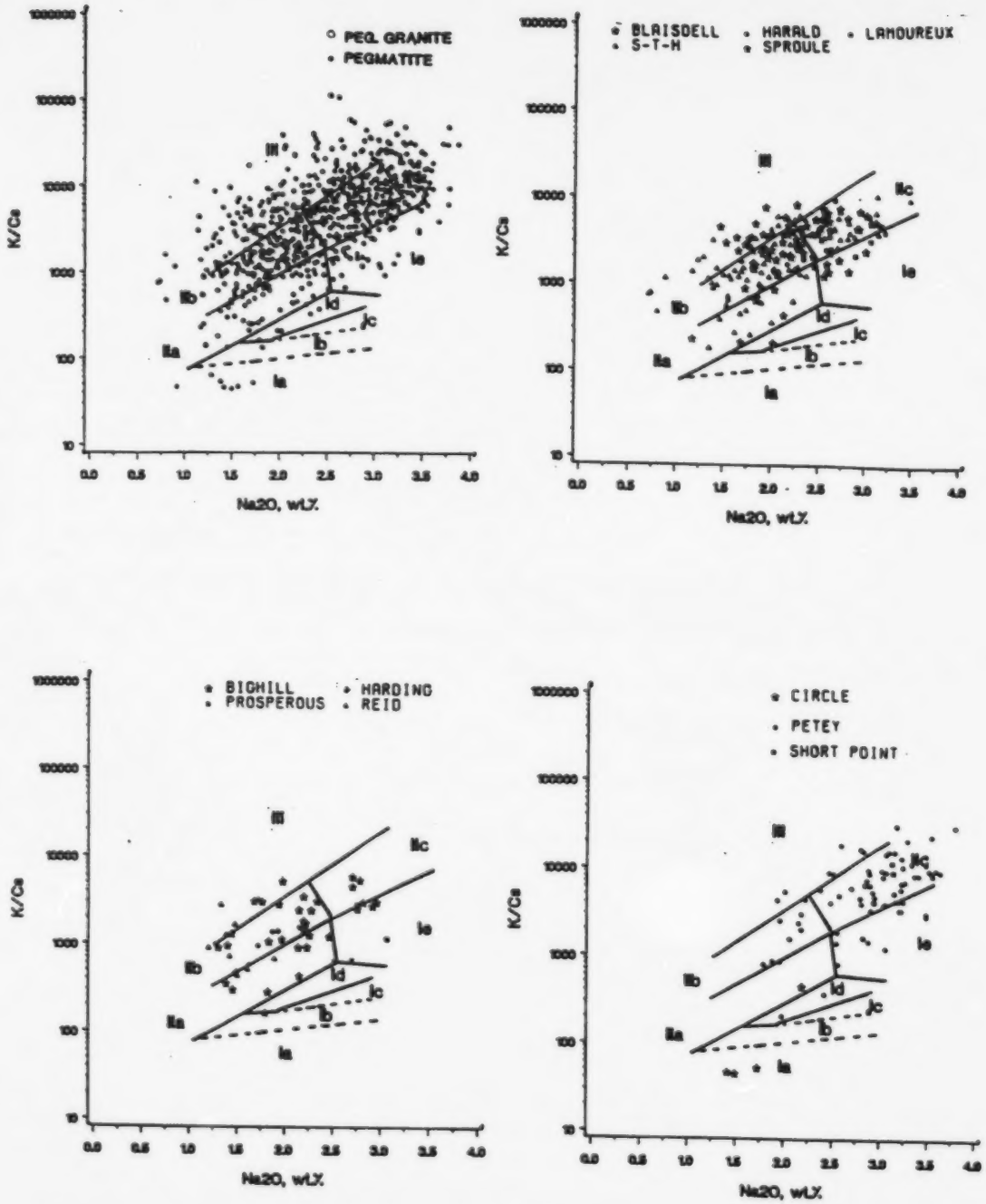

Figure 2: K/Cs vs. Na_2O plot of K-feldspar of pegmatites of the Yellowknife pegmatite field (entire field and NW area). For field descriptions see text. Fields after Gordiyenko (1976).

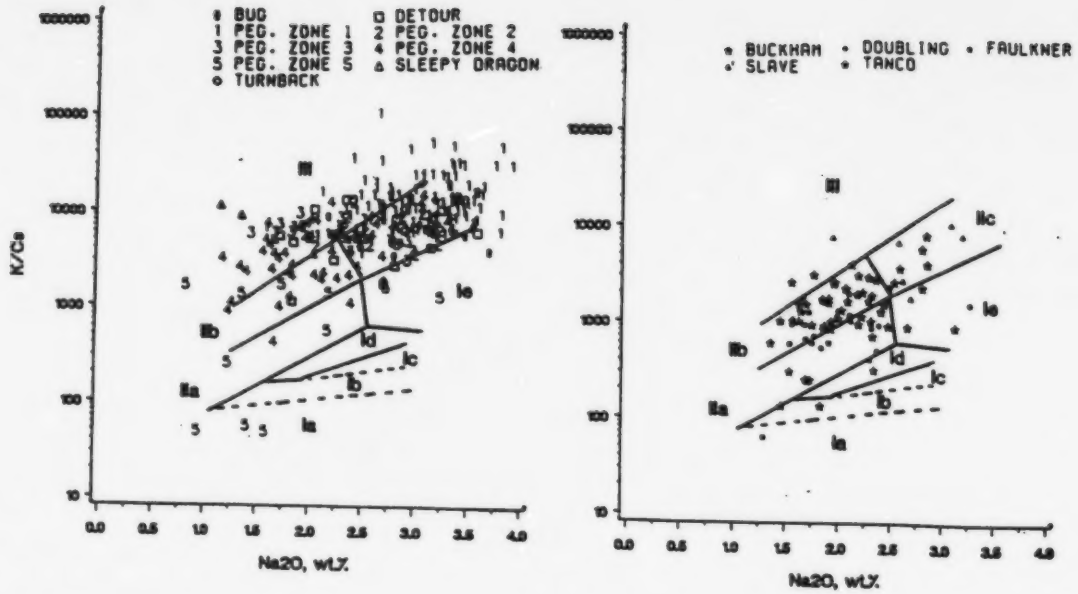

Figure 3: K/Cs vs. Na_2O plot of K-feldspar of pegmatites of the Yellowknife pegmatite field (NE, SE, and SW areas). For field descriptions see text. Fields after Gordiyenko (1976).

Dikes of the central section of the NW area populate predominantly the barren Li-type field, but a few fall within the Cs-type fields, Id and Ie. K-feldspar from the RIBER dike falls into the high-Cs field, Ia, typical of pollucite-bearing dikes.

The dikes of the NE area fall predominantly in field IIc and III showing an overall higher K/Cs, higher Na_2O tendency. A few more highly evolved dikes also fall into the Cs-type fields, Ia and Ie.

Dikes of the SE area populate the Li-type fields predominantly, although a few of each group/series fall are throughout the Cs-type fields.

Dikes of the apparently barren Great Slave Lake group of the SW area occupy predominantly the fields of barren Li-type pegmatites.

The inability to characterize all types of pegmatites in the diagrams was aloso demonstrated by Anderson (1984) in the Cross Lake field. He noted the dispersion of data throughout all fields for the Northern series, a series of pegmatites of the beryl type.

K/Rb vs. Cs in K-feldspar indicator diagram.

Figure 4 a... Figure 5 display the K/Rb versus Cs relationship for blocky K-feldspar annotated with dashed lines signifying the approximate appearance of significant mineralization in the Winnipeg River district of the SE Manitoba field according to Trueman and Černý (1982). Although Anderson (1984) found the defined fields to approximate the mineralization trend of the Southern series near Cross Lake, Manitoba, the occurrence of significant mineralization in the Yellowknife field occurs at lower degrees of rare-alkali fractionation.

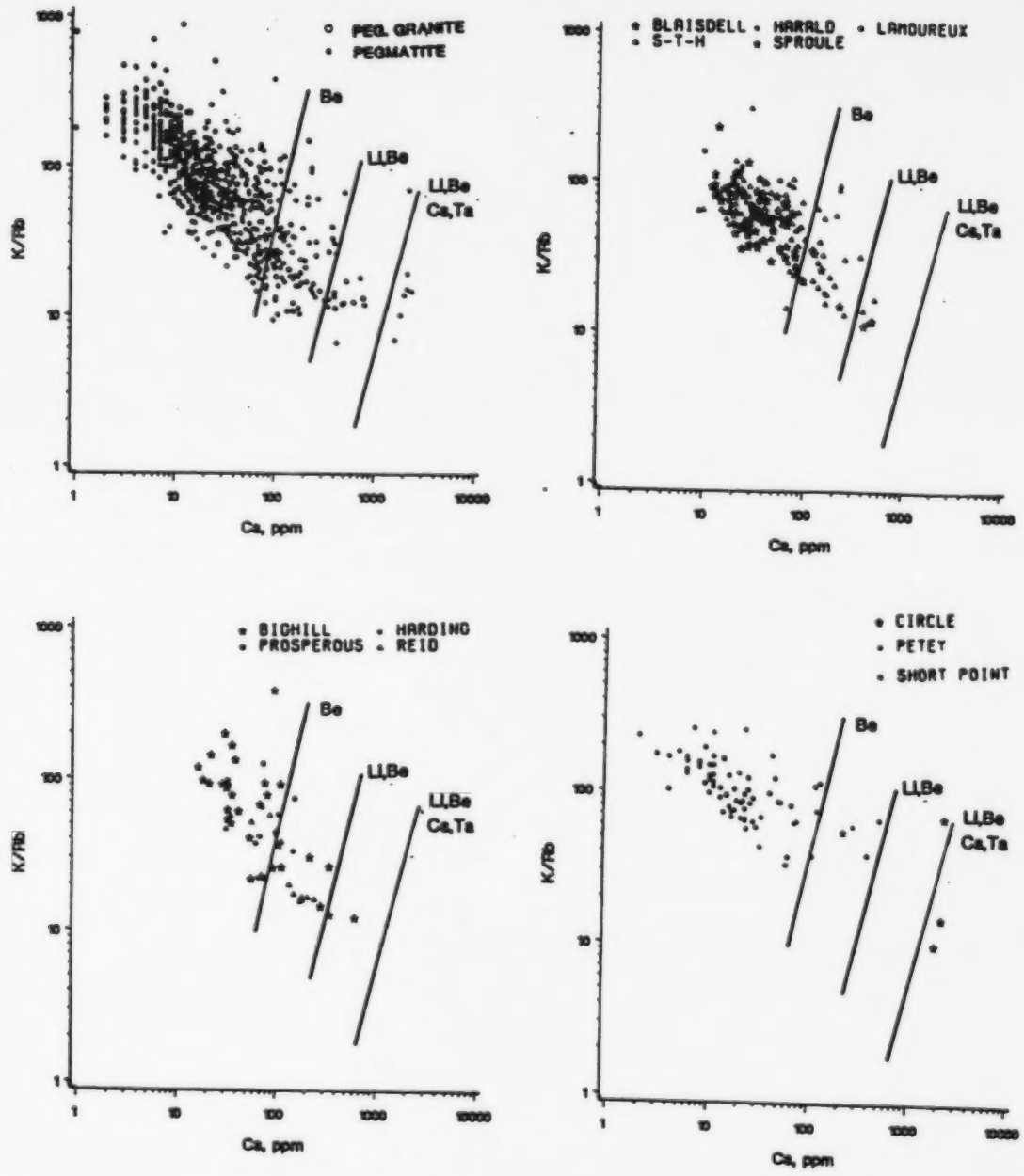

Figure 4: K/Rb vs. Cs of blocky K-feldspar of the Yellowknife pegmatite field (entire field and NW area). Line marks the beginning of significant mineralization as indicated. After Trueman and Černý (1982).

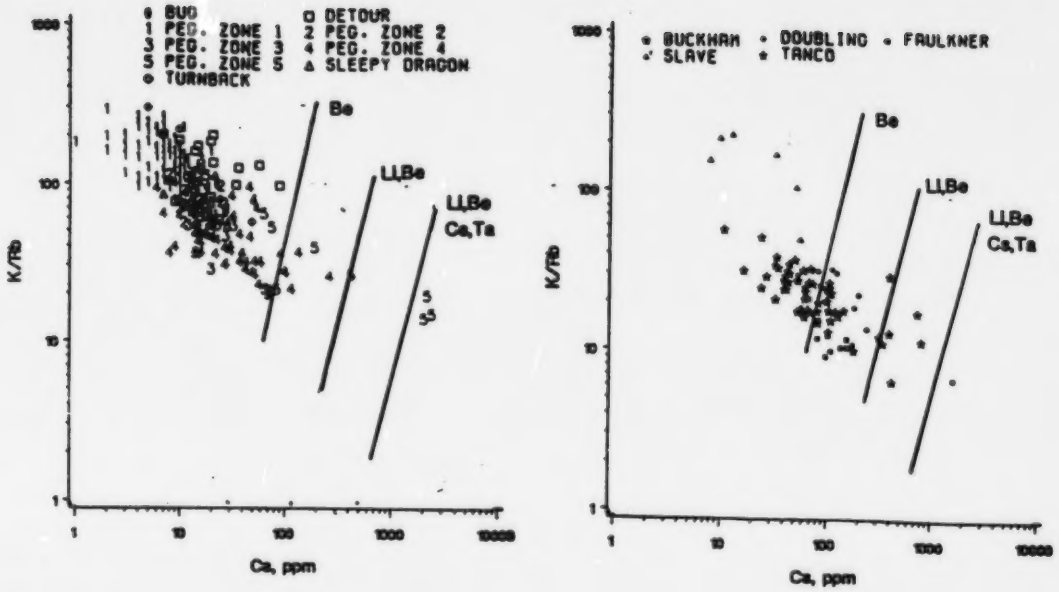

Figure 5: K/Rb vs. Cs of blocky K-feldspar of the Yellowknife pegmatite field (NE, SE, and SW areas). Line mark the beginning of significant mineralization as indicated. After Trueman and Černý (1982).

Na/Li vs. Cs in beryl indicator diagram.

Černý (1975) divided the Na/Li vs. Cs plot for beryl into fields indicative of mineralization as shown in Figure 6 for beryl of the Yellowknife field. As in the K/Rb vs. Cs relationship, the data of the Yellowknife field indicate the inception of Be, Ta, and Li mineralization at lower levels of rare-alkali enrichment. Field A of Černý (1975) contains beryl-bearing and columbite-tantalite-bearing dikes, while spodumene-bearing dikes occupy all of the 'B' field. The population of Field C in Yellowknife is minimal and Field D (not shown) is populated by a single analysis from the RIBER pegmatite.

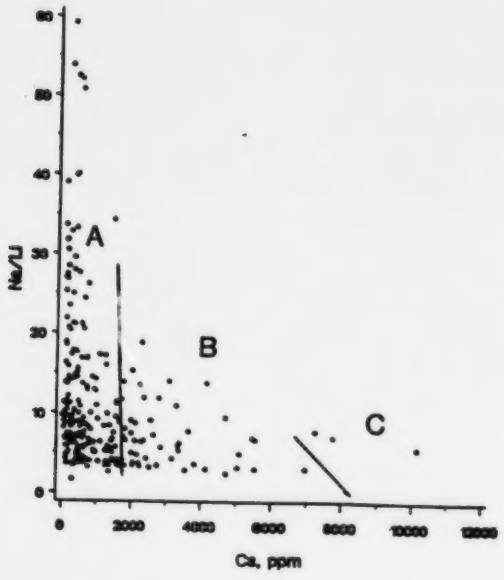

Figure 6: Na/Li vs. Cs plot of beryl of the Yellowknife pegmatite field. Lines demark the beginning of designated mineralization per Černý (1975). Field D, representing high concentrations of Cs is not shown.

Ta versus Cs in muscovite geochemical indicator.

Geochemical indicators for columbite-tantalite mineralization includes the variation of Ta with Cs in primary muscovite as proposed by Gaupp et al. (1984) (Figure 7). As summarized by Wise (1987), the Yellowknife data displays a greater variation for primary muscovite contents than denoted in the diagram of Gaupp et al. (1984), with many data points falling into the field of "late" muscovite. Moreover the Yellowknife data is typically skewed towards lower concentrations of Cs.

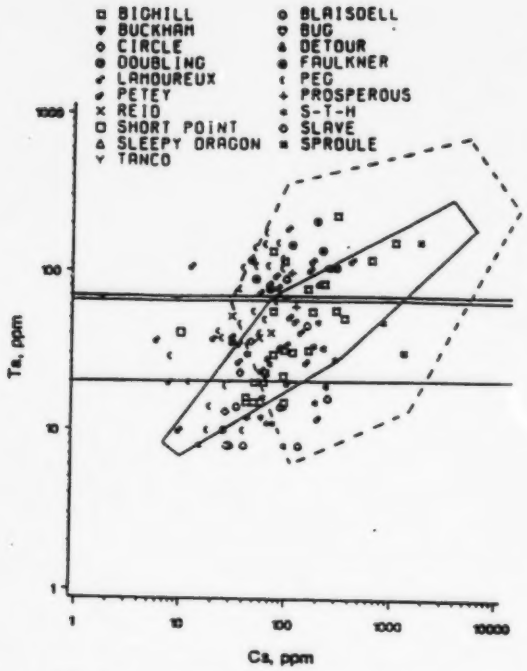

Figure 7: Plot of Ta vs. Cs in platy muscovite of the Yellowknife pegmatite field. Double line marks the lower limit of Ta-prospective localities after Gordiyenko (1970), the single line denotes the same according to Beus (1966). The solid line denotes the field of primary muscovite, the dashed line denotes the field of secondary muscovite from Gaupp et al. (1984). All plotted points are for primary muscovite. From Wise (1987).

Economic Potential and Exploration Target Areas

Economic Potential

Although overall mineralization of the Yellowknife pegmatite field is extensive, the size, grade, and spatial separation of the dikes coupled with the remoteness from world markets largely precludes any development of the field's resources in the forseeable future. Significant reserves of Li, Be, and Nb-Ta are present, although the quantity and grade of Be and Nb-Ta vary widely. Assessments of gemstone

potential appear to be exaggerated, quantities of montebrasite-amblygonite and lepidolite are insufficient for production on their own merit, and sheet mica and feldspar resources are too far removed from the marketplace for these products to be considered a resource in the foreseeable future.

Li resources.

The Li resource, as spodumene and montebrasite, is categorized as an identified paramarginal resource (Lasmanis, 1978). With an inferred tonnage of minimally 55,000,000 t at 1.41% Li_2O, it is the largest resource of Li in Canada, although the relatively low grade and distance from market will probably prevent its development in the near future (Gyongyossy and Spooner, 1979). Table 1 delineates the grade and tonnage available based on several assessments during the last decade, although none included montebrasite as part of the assessment.

Grades of spodumene are based on iron content (Ferrell, 1985), with respect to which the spodumene from the Yellowknife field is of ceramic grade, containing about 1% Fe_2O_3, with minor amounts of low iron ceramic grade (about 0.1% Fe_2O_3).

The demand for lithium, although increasing, is not expected to drastically rise. Furthermore, Ferrell (1985) indicates that world reserves exceed the cumulative demand to the year 2000 by a factor of nearly twelve. Moreover, the production of Li from brines will no doubt lessen the demand for pegmatite Li.

Table 1: Inferred lithium resources of the Yellowknife Pegmatite Field

Pegmatite Group/Series	Pegmatite Swarm	Rock Tonnage t	Grade % Li_2O
S-T-H*	FI	15,565,000	1.19
Tanco Lake	THOR ECHO/ ARACHIDE	9,352,300	1.50
Bighill Lake	BIG	8,014,200	1.47
S-T-H*	GREG	4,272,300	1.24
Blaisdell Lake	VO	3,424,400	1.48
Reid Lake	ANN & BOA	3,389,000	1.92
S-T-H*	KI	2,857,000	1.40
Harding Lake	PAINT	2,744,200	1.75
Bighill Lake	NITE	2,621,800	1.51
Harding Lake	JAKE-DA	2,096,300	1.12
S-T-H*	LU	243,000	1.26
Buckham Lake	LENS	104,200	1.97
Buckham Lake	BIN	100,700	1.75
Buckham Lake	MAC	73,800	2.00
Buckham Lake	HID	51,200	1.70
Faulkner Lake	BET	43,400	2.00
Buckham Lake	MUT	25,000	2.20

*S-T-H = Sparrow-Thompson-Hidden Lakes group.

Assessment figures are for spodumene only, they do not include montebrasite-amblygonite resources.

All inferred resource tonnages are based on Lasmanis (1978), except for those for the Harding Lake series, which are based on Stacey (1979b, 1981a), and LU swarm, which are from Morrison (1978a).

Be resources.

The Be resource from the field, as the mineral beryl, is not extensive, with the greatest concentrations occurring in the dikes of

the FERN, CASPER, BILL, and PETEY swarms, and the RIBER pegmatite. Few beryl assessments have been conducted, so the total reserve is unknown. The dispersed nature of beryl in the Yellowknife field, in general, precludes its production, except as a by-product to mining for other elements. Should the large Be deposit (phenacite, bertrandite, gadolinite) at Thor Lake in the Blatchford Lake Intrusive Suite come into production, limited mining of beryl might become worthwhile as an ancillary product depending on the milling process developed.

Nb-Ta resources.

Nb-Ta mineralization has been developed in the past with mining of pegmatites of the Upper Ross Lake group (PEG swarm), Faulkner Lake series (BET and MOOSE 2 pegmatites), and Sparrow-Thompson-Hidden Lakes group (FREDA dike). However, development ceased with the loss of governmental price supports. Exploration and assessment of pegmatites has continued, nonetheless, and Table 2 summarizes average assay values for dikes of the field as compiled by Wise (1987).

Although Ta prices boomed in the late 1970's and early 1980's, they have decreased markedly from the high annual price of US$126.37 in 1980 per pound of contained Ta in concentrate to US$30.60 in 1983 (Cunningham, 1985). As noted by Cunningham (1985), the future of Ta consumption is difficult to predict due to the erratic variation in demand recently. Nonetheless, an average annual growth rate worldwide of 3.2% is predicted until the year 2000. The present demands of Ta are largely met as a by-product of the tin mining and smelting industry, but, as the growth in the world demand of Sn is only expected to be about 1%, Ta production from other sources must make up for the increased demand.

Table 2: Average niobium, tantalum, and tin assay values of some pegmatites of the Yellowknife pegmatite field.

Pegmatite Swarm/Pegmatite	Nb	Ta	Sn
ANN & BOA[2]	-	0.004	-
BET[9]	0.01	Tr.	0.016
BIG[3]	-	0.002	-
BIG HILL[13]	0.01	0.045	0.035
FI[4]	-	0.002	-
FLY[10]	0.01	0.01	-
FREDA[12]	0.01	0.01	-
GREG[1]	-	0.003	-
JAKE-DA[14]	0.006	0.003	-
MOOSE[7]	0.04	0.02	-
NITE[5]	-	0.007	0.006
PANCHO VILLA[15]	0.003	0.006	-
TAN[16]	-	0.07	-
THOR ECHO/ARACHIDE[6]	-	0.003	-
USK[11]	Tr.	Tr.	-
VO[8]	-	0.002	-
WAS[11]	0.01	Tr.	-

All values are in elemental weight percent. Data taken from: 1 - Morrison (1975b), 2 - Morrison (1975a), 3 - Morrison (1975c), 4 - Morrison (1975e), 5 - Morrison (1975k), 6 - Morrison (1975m), 7 - Groves (1978), 8 - Morrison (1978), 9 - LeCouteur (1980a), 10 - LeCouteur (1980c), 11 - LeCouteur (1980d), 12 - LeCouteur (1980e), 13 - Thomas (1980), 14 - Stacey (1981a), 15 - Stacey (1981b), 16 - Thomas (1982). After Wise (1987).

Despite the overall prospective increase in demand of Ta, the low Ta/Nb ratio in Yellowknife pegmatites, the small pegmatite size, and the distance from markets will probably preclude Nb-Ta mining in the foreseeable future as a primary production.

Exploration target areas

Despite the gloomy economic picture, discovery of more mineralized and larger pegmatites would alter the picture considerably.

Exploration in the Yellowknife field should be directed towards those geographical areas associated with increasing regional trends, indicating increasing evolution of the pegmatites, using such indicators as K/Rb and K/Cs in K-feldspar and mica, Nb/Ta in mica, and Na/Li vs. Cs in beryl. Additionally, geochemistry should be coupled with the analysis of structural details in view of finding structural relations amenable to the intrusion of pegmatites.

In light of findings of this and previous studies, several areas warrant further examination in view of locating pegmatites of economic value.

In the northwestern area, the regional zonation of pegmatites east and south of the Duncan batholith provides guidance in the exploratory effort, but not so in the central section. Thus, in consideration of the evidence available, exploration is suggested as follows:

1. NE section: Regional zonation east of the Duncan batholith indicates a generally increasing degree of fractionation towards the east along the entire section from north to south. This suggests that exploration should be conducted

east of the more fractionated dikes of the groups within the section and west of the mapped cordierite isograd. Specific areas include:

a. East of the VO swarm in the wide expanse of medium-grade metasedimentary rocks,

b. NNE and NW of Sproule Lake in respect to the overall trend set by the Harald and Sproule Lake series (Proterozoic faults have probably offset the trend arrangement to the west), and

c. The area east of the FREDA pegmatite towards Otto Lake.

2. Southern section: The spodumene-bearing and beryl-, columbite-tantalite-bearing dikes indicate a high degree of evolution, suggesting further exploration in the area between Egg Lake in the SE to Tom Lake in the NW, in the direction of regional geochemical and mineralogical trends. In addition, the dikes of the Upland Lake series warrant further examination to establish the existence of any regional trends in that area.

3. Central section: The section appears to represent a region situated above an underlying pluton with the surface populated by cupolas of granite and fingers of pegmatitic granite. This would suggest that the more fractionated dikes have been obliterated by erosion as they would have been situated geologically above the present surface. The presence of pegmatites such as the Circle Lake series and the DIKE swarm of the Petey Lake series suggests, nonetheless,

the possibility of further exploration in the vicinity of and between these pegmatites. Furthermore, due to the highly fractionated nature of the RIBER dike, it bears further exploration by drilling to establish zoning, mineralogy, and size.

Due to the competency of the host rock in the northeastern area, it appears that pegmatite evolution was restricted here to zones of shearing or older magmatic conduits such as in the Upper Ross Lake - Redout Lake area. Nonetheless, further exploration is suggested NW of the PEG swarm along the regional trends and SW of Upper Ross Lake in an area of medium-grade schist. In addition, due to the high degree of differentiation of the Abediah and Goon plutons, exploration is warranted in the surrounding gneiss, especially where there is evidence of shearing during the Archean. In this regard, the shear zone along the contact of the Sleepy Dragon Complex and the Sunset Lake Basalt deserves examination.

Due to the lack if any indications of significant fractionation within the pegmatites, there appear to be no areas in the southwestern area that deserve any further exploratory effort.

The southeastern area probably holds the greatest potential of still retaining much of the pegmatite 'crown' above the parental granites and as such deserves attention in any exploratory program. As noted in the discussion of genetic relationships, the wide expanse of medium-grade schist in the west-central section pierced by a lone stock of Prosperous Granite, suggests the existence of a larger granite beneath the surface. In addition, the presence of

the Faulkner Lake series about a pluton of the Defeat Plutonic Suite, suggests the possibility of a Prosperous Granite intrusion along the magma conduit of the granodiorite. Furthermore, the high degree of evolution of the pegmatites suggests that the present erosional surface may intersect the pegmatitic aureole towards its zenith. This would entail the possibility of pegmatites of equal or higher levels of fractionation near the surface. Location of such pegmatites would probably require a combination of geophysical and geochemical methods.

The Aylmer Lake-McKay Lake area

The Aylmer-McKay Lake pegmatite field is located between 63-65°N and 108-112°W. The area is covered by the gological maps Lac de Gras (Folinsbee 1947, 1949), Aylmer Lake (Lord and Barnes 1954), McKay Lake (Henderson 1943) and Walmsley Lake (Folinsbee 1952).

Several plutons of biotite-muscovite granites with local pegmatitic facies were mapped in this field, the most prominent one stretched from the SE end of Lac de Gras to the SE, along the SW side of Aylmer Lake. Numerous pegmatitic granites were also recorded, notable at the N side of Thonokied Lake; at the central, W and N parts of Aylmer Lake; and at Tarpon Lake.

The pegmatite-bearing area covers an area of approximately 13,000 km^2. Mineralized pegmatite bodies were marked at the following localities:

E of the SE end of Lac de Gras (Be);

at the SE end of Lac de Gras (Li);

at the NE end of McKay Lake (Li, Ta);

W of the Narm of Aylmer Lake (Li);

N of Muskox Lake (Ta, Nb);

in the corner between the N and W arms of Aylmer Lake (Li, Be);

N or Reid Lake and Margaret Lake (Be, Li);

southernmost extremity of Aylmer L. (Be).

No mineralized pegmatites were recorded on the McKay Lake sheet, which is not necessarily indicative of their actual absence.

Economic considerations

The meager data available for the Aylmer Lake-McKay Lake area do not permit any rigorous evaulation of its pegmatite potential. Paragenesis of the rare-element minerals indicates qualitative possibilities for Li, Be and

Nb-Ta. However, further work is necessary in the area to upgrade the present reconnaissance-grade knowledge of the area to a degree permitting educated appraisal.

The Benjamin Lake area

The Benjamin Lake pegmatite field seems to be of smaller dimensions, located between $62^{o}55'$ - $63^{o}20'$N and $40^{o}30'$ - 111^{o}W. The area is documented on the geological maps Benjamin Lake (Heywood and Davidson 1969) and Christie Bay (Stockwell et al. 1968).

Pegmatitic granites were mapped in this field at the flanks of a granitic batholith on the N shore of McLeod Bay, and pegmatite localities of beryl and columbite-tantalite were recorded from the area.

Economic considerations

Virtually nothing is known about the pegmatite potential of this area, except the mere presence of a few pegmatites. These were reported in the course of initial regional mapping, and their number and description do not necessarily reflect their actual distribution and mineralogy. Further work is required to evaluate the pegmatite resources of this area.

CENTRAL BAFFIN ISLAND

Extensive pegmatite population(s) are reported from the central parts of Baffin Island. This segment, approximately 250 x 350 km in size, is underlain by the early Aphebian Piling Group of metasediments, largely pelites, arkoses, limestones, dolostones and quartzites with basic volcanic and intrusive gabbroic to ultra basic rocks (Fig. A). The Piling Group rests unconformably on an Archean basement, represented on the erosion surface by the McBeth Gneiss Dome. Metamorphism of the Piling Group is largely of the lower amphibolite facies, with an elongate belt of greenschist facies to the

southwest (Fig. B).

Further information on the regional geology and metamorphism is available in Jackson and Morgan (1978, whereas large-scale tectonic evolution is treated by Tippett and Morgan (1987).

Numerous pegmatites are reported from the areas west of the heads of Hirbilung and McBeth Fiords (Fig. A). Most of these are barren dikes consiting of feldspars, quartz, muscovite and biotite, locally with garnet or tourmaline. Beryl is occasionally observed, but no other rare-element minerals. The only exception to this rule (?) is the PLEX pegmatite described below, which contains relatively abundant columbite; spodumene is also reported from float in the close vicinity of this locality.

The PLEX pegmatites

The PLEX pegmatites are located in central parts of Baffin Island, 2.5 km south of the southern shore of the proglacial Generator Lake, at the southeastern termination of the Barnes icesheet ($69^{o}32'N/71^{o}56'W$; Fig. A). The lake has open water surface, on the average, only 10 days/year in the end of July and early August. Consequently, the only practical access is by helicopter from the DEW-line base at Hall Beach or DEW-line stations along the west coast of Baffin Island.

The pegmatites were first described by Kranck (1955) who recognized the main rock-forming and accessory minerals. Later notes came from Henderson (1980) and Henderson and Tippett (1980).

The pegmatites were staked under claim by COMINCO in summer 1979, and examined by Tantalum Mining Corporation of Canada Ltd. personnel (under a joint-venture agreement) plus the present author in 1981. The

1 – Lake Harbour Group
2 – Hall Peninsula
3 – Hoare Bay Group
4 – Nettilling Lake – Penny Ice Cap
5 – Piling Group
6 – Mary River Group
7 – Eclipse Sound – Pond Inlet

Figure 4. Regional subdivision of supracrustal strata on Baffin and Bylot islands. From Jackson and Morgan (1978).

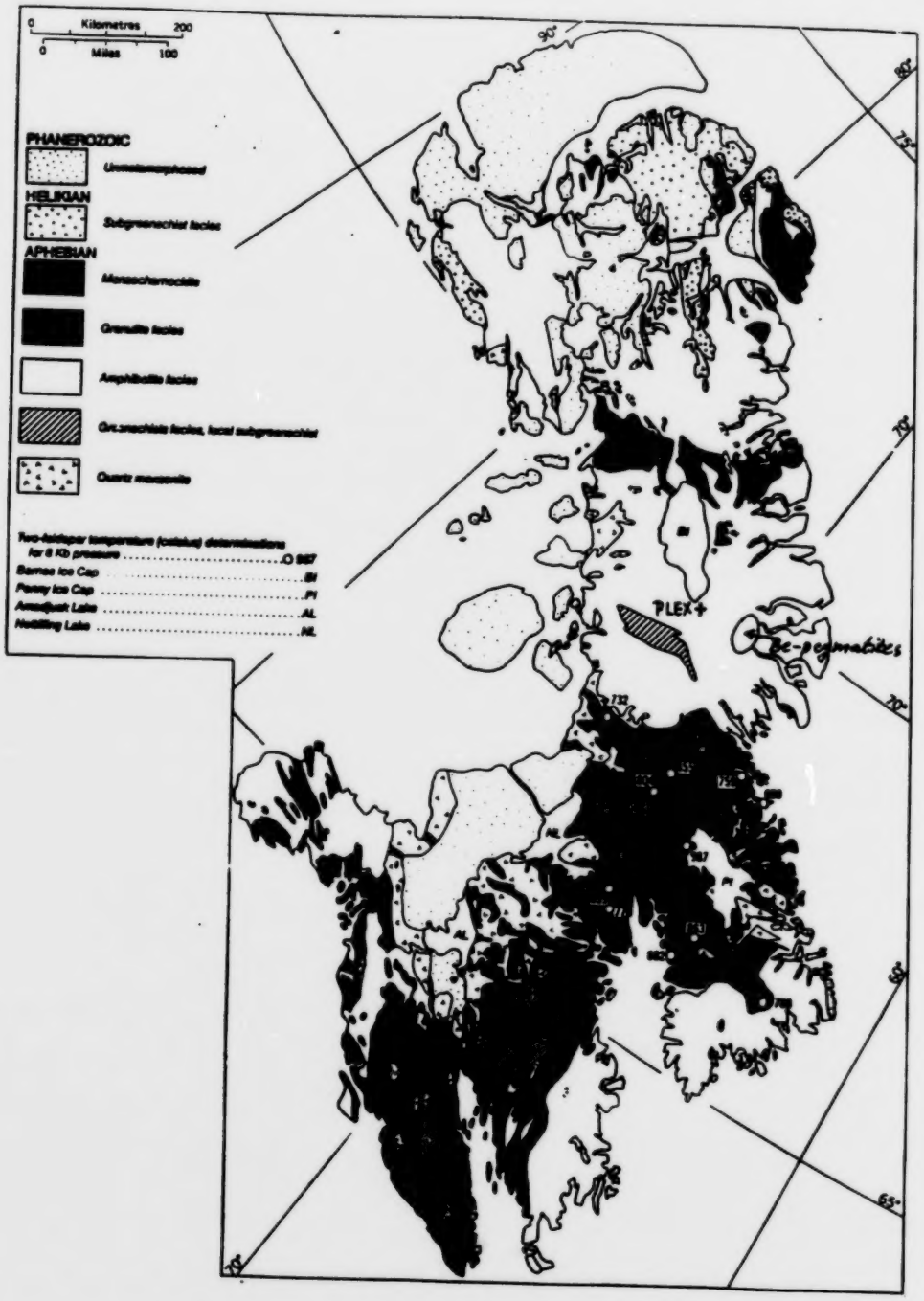

Figure B. Metamorphic subdivision of Baffin and Bylot Islands. From Jacson and Morgan (1978).

COMINCO claims expired in December 1987 and the ground is at present open.

The PLEX pegmatites are emplaced along the contact of metasediments overlain at a shallow angle by metabasalts. The metasediments are represented by biotite-quartz-garnet paragneiss, locally studded by subhedral to euhedral staurolite. In the vicinity of the pegmatites, this paragneiss contains abundant porphyroblasts of black tourmaline. The metabasalt is metamorphosed into amphibolite with very low content of felsic minerals. Exocontact effects are limited to a narrow biotitized seam; tourmaline or other reaction products were not observed. The metamorphism of the country rocks in the area of Generator Lake corresponds to amphibolite facies.

Two pegmatites can be distinguished in the field, designated here as the Upper (PX) and Lower (LPX) pegmatite.

The Upper pegmatite is a sill-like body emplaced along the lithological paragneiss/amphibolite boundary. It is exposed on a northwest-facing slope along a length of 80 m, with scattered outcrops discernible along a total length of about 200 m. The pegmatite dips shallowly to the southwest (20-25^{o}, exceptionally up to apparent 50^{o}). Thickness is variable from about 1.2 m in the northeasternmost exposure to a minimum of 2.5 m in the central parts.

The Lower pegmatite is poorly exposed below the central parts of the Upper pegmatite outcrop. Its upper contact can be locally discerned but the footwall contact is hidden, as are the flanks of the cca 15 m long outcrop, under a thick layer of slope talus.

The Upper pegmatite consists of essentially three units: a wall zone, an intermediate (core-margin) zone, and a core.

The wall zone consists essentially of albite, quartz and muscovite, with subordinate garnet and tourmaline. In the northeasternmost exposure of the upper pegmatite, the wall zone is the exclusive constituent of the pegmatite over its entire width, poor in muscovite but extremely enriched in garnet and tourmaline. Both these minerals are intergrown here with quartz in a quasi-graphic pattern. In the central parts of the pegmatite exposure, the wall zone is relatively thin, enriched in plumose and platy muscovite, poor in garnet and locally lacking tourmaline.

The intermediate (core-margin) zone consists of grey to milky quartz, white blocky K-feldspar, subordinate to accessory book muscovite and columnar tourmaline. Pods of löllingite also occur in this unit.

The core is largely monomineralic, composed of milky quartz but it also contains gigantic columns of black tourmaline (up to 0.15 x 1.5 m), studded by zircon and columbite crystals on their surfaces. In the vicinity of columbite and zircon, the quartz is (brownish) black, with a gradual transition into the milky type.

The lower pegmatite is not exposed enough to reveal its internal structure. The limited outcrop shows virtually exclusively a unit of medium-flaked greenish-yellow muscovite with local small patches of quartz and dispersed pods of albite. Accessory columbite is found disseminated throughout the muscovite masses.

Albite is present dominantly as cleavelandite. Saccharoidal albite is extremely rare. In the wall zone, albite near contacts with wallrocks shows optical properties corresponding to An_5 - An_7; in the internal parts of the wall zone and in the core-margin, the composition is close to An_2 - An_3.

Microcline-perthite is largely white, with near-maximum values of triclinicity (0.88-0.95). The sodium contents are relatively high (2.48-3.28 wt.% Na_2O), whereas the levels of rare-alkali fractionation are moderate (K/Rb 54-24, K/Cs 100-3200) (see the results of chemical analyses in the appendix).

Muscovite belongs without exception to the common $2M_1$, polytype. In the Upper pegmatite, muscovite chemistry is relatively primitive, as indicated by the poor rare-alkali fractionation (K/Rb 25-35, K/Cs 1300-2700), low Li content (0.25-0.27 wt.% Li_2O) and high Fe (total Fe as Fe_2O_3 2.2-2.8 wt.%). In contrast, the medium-flaked muscovite from the Lower pegmatite is much more evolved (K/Rb 10-18, K/Cs 170-680, Li_2O 0.24-0.27; Fe is high but the Fe/Mn ratio is distinctly lower; see the results of chemical analyses in the appendix).

Garnet forms dark red crystals up to 3 cm in size, or quasi-graphic intergrowths with quartz that reach 12 cm across, in the upper pegmatite. The composition is largely close to Alm_{50} $Spess_{50}$, with only very minor Ca contents and Mg below the detection limit of the electron microprobe under standard operating conditions (cca 0.10 wt.% MgO). Only the garnet that occurs in minor quantities with muscovite in the core-margin of the pegmatite reaches the composition of Alm_{22} $Spess_{78}$ (see garnet microprobe analyses in the appendix).

In contrast to the above, garnet from the Lower pegmatite is distinctly more fractionated. Its reddish orange grains, found with albite in the albite clusters within the medium-flaked muscovite masses, range from 59 to 78% in the spessartine content.

Tourmaline is black in color, and ranges from dendritic aggregates finely intergrown with albite, through coarse-grained quasi-graphic

intergrowths with quartz, to the aforementioned gigantic columnar crystals in the core. Its composition is somewhat variable within individual crystals, showing oscillatory concentric zoning, but within relatively narrow limits. Compared to coexisting garnet, the tourmaline is always seen to incorporate Fe perferentially, being very poor in Mn relative to garnet. The Mg content is variable, being the highest along the wallrock contacts (3.40 wt.% MgO) but low in the internal units (0.0-0.6 wt.% MgO). The black tourmaline from the footwall parageneiss is, however, Mg- and Ti-rich. Dravite is the far dominant component in this tourmaline (see microprobe analyses of tourmaline in the appendix).

Beryl was found in only one specimen in the slope talus beneath the Upper pegmatite but above the Lower dike. It is associated with cleavelandite and garnet. The 2.5 x 10 cm crystal is considerably altered and stained by manganese oxides. Consequently no attempt was made to separate pure material for chemical analysis. However, identification was secured by X-ray powder diffraction.

Columbite of the Upper pegmatite forms flat columnar crystals averaging about 1x3x7 cm in size but occasionally reaching 5x10x16 cm. Embedded in otherwise milky quartz, the columbite crystals develop a halo of smoky color up to 15 cm wide. Compositionally, the mineral corresponds to ferrocolumbite with narrow ranges of Fe-Mn and Nb-Ta substitutions (Fig. 2).

Columbite of the Lower pegmatite forms anhedral to brick-shaped subhedral grains that average 1 cm in size. They are somewhat enriched in Ta and distinctly enriched in Mn. Their restricted compositional range is confined to the manganocolumbite quadrangle of the columbite quadrilateral (Fig. 2) (see appendix for compositional data of both

columbite types).

Structurally, columbite from both the Upper and Lower pegmatites display intermediate degrees of cation ordering, with a peculiar bimodal distribution of structural states (Fig. 2). No explanation is available at present for this feature, which is to the best of my knowledge unique. On heating, all examined specimens develop more or less completely ordered structure.

Zircon is found in the form of radial aggregates of columnar crystals averaging 0.6 cm in length, growing on the surface of tourmaline crystals in the core-margin unit and in the core. It is metamict but the structure can be reasonably restored by heating. Metamictization is expressed in the electron microprobe analysis by low total and deviations from stoichiometry. The low content of HfO_2 indicates rather poor fractionation level.

Löllingite was found in the southern end of the main exprosure of the Upper pegmatite. It forms a sizeable pod there, at least 20 cm across, in quartz and K-feldspar of the core-margin unit. It was unambiguously identified by X-ray powder diffraction.

Uranophane was found as an alteration product of zircon. It forms pale-yellow powdery coatings on the surfaces and within fractures of zircon. No compositional data are available but the X-ray powder diffraction data yielded a reliable identification.

Scorodite is an abundant alteration product of löllingite. The green microcrystalline material is contaminated by relics of löllingite and too soft for mounting; consequently, no chemical analysis was possible. However, X-ray diffraction provided an unambiguous identification.

The internal structure, rock-forming minerals and the assemblage of accessory phases rank the Upper pegmatite with the beryl-columbite subtype of the beryl type of rare-element granitic pegmatites (Cerný 1986, 1988). If the mineralogy at the present level of exposure is characteristic of the whole 3-dimensional body of the pegmatite, we have a considerably anomalous relationship here, with relatively abundant columbite dominant over truly rare beryl. A reverse ratio is the "rule" in pegmatites of this type.

The geochemical signature of the Upper pegmatite corresponds to the range typical of the beryl-columbite subtype, comparable to other occurrences documented by, e.g., Cerný et al. (1981) and Meintzer (1987).

The Lower pegmatite cannot be completely characterized because of poor exposure. It could be somewhat more evolved than the Upper body, but pods of more fractionated mica are documented from the central parts of beryl-columbite pegmatites (e.g., Cerný et al. 1981, 1988). It is quite possible that the exposed micaceous pod may reside in central parts of a zoned pegmatite which otherwise corresponds, geochemically and paragenetically, to the composition of the Upper pegmatite.

Economic considerations

Remote location and transport difficulties aside, the Central Baffin Island area does not seem to be promising at first glance. So far, beryl is the only mineral reported with some frequency; Ta-poor columbite is known only from the PLEX claim, and spodumene is reported from glacial float in the PLEX area.

However, the overall intensity of exploration of Central Baffin Island is low, particularly from the viewpoint of pegmatite potential.

Further work is required to establish the regional characteristics of its pegmatite population.

CHANTREY INLET

Finds of good quality beryl from pegmatites in the general area of Chantrey Inlet were reported by an unnamed prospector to the Geology office, INAC Yellowknife. No published record exists on pegmatites from this region, and regional geology is poorly documented.

It is evident that a thorough field work is required to assess the pegmatite resources of the Chantrey Inlet area, from fundamental regional geology and petrography to the distribution and nature of granitic intrusions and pegmatites.

DISCUSSION

Comparison of the three areas of interest

The Yellowknife pegmatite field is well established as a pegmatite field with a Li,(Rb), Be,(Sn), Nb-Ta,Fe>Mn signature, poor in F, and of a relatively high pressure/low temperature type because of the apparent absence of petalite; spodumene is virtually the only lithium aluminosilicate present. With extremely few exceptions, only the barren, beryl (beryl-columbite, beryl-columbite-phosphate) and complex (spodumene) pegmatite types (subtypes) are encountered here.

The pegmatites identified so far in the Aylmer Lake-McKay Lake area seem to belong to the beryl (beryl-columbite) and complex (spodumene) types. The pegmatite population of this region is probably more dispersed than in the Yellowknife field, and its relationship to potential fertile granites is unknown.

Pegmatites of the Benjamin Lake area are so far very few, and the maximal fractionation degree indicated is that of the beryl-columbite

subtype. Candidates for the parental granite types have not yet been identified.

The pegmatite population of Central Baffin Island is in general much more primitive than that of the Yellowknife field. Barren and beryl pegmatites predominate in a mainly metasedimentary terrane, marked by higher average metamorphic grade and apprently minimal outcrop of parental granites.

As to the Chantrey Inlet pegmatite area, the present data do not permit any comparison.

Recommendations

(i) The Yellowknife field has been examined in sufficient detail now to consider the evaluations of Meintzer (1987) and Wise (1987) definitive. No further work seems to be necessary which may lead to potential refinements of economic considerations. Exploration guidelines are spelled out in the above theses, and reproduced in part in the preceding part of this report.

(ii) The Aylmer Lake-McKay Lake area will be examined in 1988-1990. Detailed examination of the known pegmatites search for new pegmatite localities, and reconnaissance studies of plutonic granitoid rocks and metamorphic grades of country rocks will be conducted over the next two years. The full program of this study was outlined in the research proposal of February 16/1987.

(iii) The Benjamin Lake area also deserves examination, and was included in the research proposal quoted above. However, due to the funding level considerably reduced relative to the proposes budget, this area will most probably have to be omitted in the 1988-1990 program. Some reconnaissance work may be done in 1989, funds and time permitting.

Otherwise, search for and study of the pegmatites and a preliminary appraisal of granitoid rocks and metamorphic grades of the pegmatite-bearing area are recommended as a separate project in the future.

(iv) Central Baffin Island is a promising pegmatite area, despite the apparent lack of highly frctionated, rare-alkali enriched pegmatites. A regional survey should be considered for the future, that would cover (A) the area between Generator Lake and the Hirbilung and McBeth Fiord heads, and (b) from Generator Lake to the south, to the lower amphibolite-greenschist facies transition which is usually the earmark of metamorphic terranes hosting the geochemically most evolved pegmatite deposits.

Such a survey should include geochemical sampling and analysis of granites and pegmatites, reconnaissance of variations in metamorphic grade of the regional lithologies, and documentation of the accessory mineralization.

(v) No definite proposal can be made at this time for the Chantrey Inlet pegmatites. Provided separate funding could be found, it is recommended that the field party (+ principal investigator) conducting theAylmer-McKay Lakes study in summer 1988 are sent to the Chantrey Inlet, to examine the beryl-bearing pegmatites under the guidance of their discoverer. Further course of action can be taken on their advice; it seems to be evident that this virtually virgin area will require a gradual build-up of geological information, starting from reconnaissance regional mapping.

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